NIGER DELTA UNIVERSITY
WILBERFORCE ISLAND, BAYELSA STATE.

45th Inaugural Lecture

Boundless Mathematics:

The Novelty of Applications to Life & Panacea to Living

BY

Promise Mebine

BSc (Hons) (Pure & Applied Mathematics) RSUST, Nigeria
MSc (Applied Theoretical Physics) RSUST, Nigeria
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NIGER DELTA UNIVERSITY
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Motto
Creativity, Excellence, Service

Vision
To be a centre of excellence defined by well articulated programme that will produce creative and innovative minds

Mission
To strive to maintain an international reputation for high quality scholarship, research and academic excellence for the promotion of thesocio-cultural and economic well-being of mankind

NIGER DELTA UNIVERSITY ANTHEM
(THE BRIGHTEST STAR)

Like the brightest star we are, to lead the way
To good education that is all our due,
The dream of our fathers like the seed has grown;
Niger Delta University if here to stay.

Let us build on this noble foundation
And with love, let our dedication increase,
To rise and uphold this noble vision
Ev'ry passing moment let our zeal never decrease.

In all that we do, let us bring to mind
Our duty as staff and students of N.D.U
Ev'rywhere to promote peace towards mankind.
Creativity, Excellence and Service

CHORUS
Rejoice, great people old and new, rejoice
For the good fruit through us is shown;
Be glad in our worthy contribution
To the growth of humanity (x2)

Dedication

I dedicate this inaugural lecture to God Almighty who made it possible for me to deliver this lecture today. I return all glory to him.

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1. Introduction

Permit me to begin my Inaugural Lecture today by registering my deep appreciation to God, Who, by His infinite wisdom made it possible for me to give the First Inaugural Lecture in Mathematics to the Niger Delta University. "*In Him 'I' live, and move and have 'my' being; … for 'I' also His offspring.*"- paraphrased from Acts 17:28 (KJV), and therefore, I ascribe all praises and glory to God, for He is the fountain of my life.

What does it mean to give an Inaugural Lecture? To me, it is simply the 'formal beginning' of inauguration into the cadre of a Professor, though I became a Professor in 2017. In some other context, it is generally believed to be a 'debt' owed to the University community by a Professor, which is expected to be paid before disengagement. You will soon realise; the reverse is the case that it is a debt you owed me for coming to listen to me!

Today, I propose to demystify Mathematics; and if I do not completely succeed in that effort, it will be because of its being inseparably interwoven nature with other disciplines and philosophy. My plea would be the same as that of the young man who was scolded by his father for indulging over-much in poetical language. He replied: "*Father forgive, I will no more verses make.*"

This Inaugural Lecture, **"Boundless Mathematics: The Novelty of Applications to Life and Panacea to Living"**was inspired by my curiosity with Applied Mathematics as a place where the actual world meets the 'Mathematical Structures and Techniques' that underpin most solutions to socio-economic, political, environmental, industrial, and engineering challenges.Mathematical structure, i.e., the spatial and quantitative, is one of God's inborn traits (Isaiah 40:26). To put it another way, the aesthetically beautiful concerns in Mathematics suggest that God is concerned with consistency and precision and that Mathematics is an important component of creation (Genesis 6:14-16).

2. What is Mathematics?

Mathematics does not have a single, all-encompassing definition. Because of its universality and wide range of applications, Mathematics means many different things to various people (Adepoju, 2004). In today's competitive world, nations facing environmental, scientific, and technical difficulties even the emergence of COVID – 19 Pandemic, need innovative ideas and optimal solutions, and Mathematics plays a critical role. Some of the primary "characters, societies, and cultures, including the Ancient Egyptians and Pythagoreans," as well as renowned people like Galileo, Dodgson, Babbage, and Lovelace, have a long and illustrious history of bright minds and game-changing discoveries in Mathematics (Beveridge, 2016).As a result, it is necessary to provide a categorised summary of some of the various perspectives and definitions of Mathematics as articulated by various persons at various eras.

(a) Richard Courant (1888 - 1972), a German mathematician, defined "*Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality, and individuality.*"

(b) Mathematics can signify any of the following things to those who think about it in terms of how it helps them understand nature, patterns, and the world itself (Pickover, 1997; Stewart, 1995; Bell, 1961): "The loom upon which God weaves the fabric of the universe;" "the science patterns;" "a conducting thread connecting scientific ideas with an understanding of our environment;" and "a formal system of thought for recognizing, classifying and exploiting patterns developed by the human mind and culture."

Galileo (1564-1642) declared under this category that "the universe is a grand bank which cannot be understood unless you understand the language of Mathematics in which it is written." As a result, it is thought that the world is made up of mathematical threads.

(c) To individuals who consider Mathematics to be a useful subject (Condoorcet, 1988; Richardson, 1968):
- "Mathematicsis a systematic way of digging out the rules and structures that lie behind some observed patterns or regularity, and then using those rules and structures to explain what is going on."

-"Mathematics is a landscape, with an inherent geography that its users and creators employ to navigate through what would otherwise be an impenetrable jungle."

-"Mathematics is the ultimate mental technology transfer in which ways of thinking rather than machines are being transferred."

-"Mathematics is the science that yields the best opportunity to observe the workings of the mind…and has the advantage that by cultivating it, we may acquire the habit of a method of reasoning which can be applied afterwards to the study of any subject and can guide us in the pursuit of life's object."

-"Mathematics is the language of science and technology."

(d) To the expertise considerations of Philosophers, logicians as well as artists and their literary academic counterparts (Bell, 1961; Hardy, 1976): “Mathematics is seen as the science of quantity;” “the science of counting;” “a subject concerned with goodness and beauty;” “the Queen and servant of Science;” “Science of self-evident things;” “the nearest thing to an international language;” “the most fascinating mental game ever created by man;” “a discipline that includes every subject in which you attempt to reason logically from explicitly recognized underlying assumptions as expected in any subject forming part of the research for truth;” “International activity;” “a necessary evil.”

Prochus' (410–485) artistic remark about Mathematics (Roy, 1979) falls into this category: “She reminds you of the invisible form of the soul;
She gives life to her discoveries;
She awakens the mind and purifies the intellect;
She brings light to our intrinsic ideas;
She abolishes oblivion and ignorance which is ours by birth.”

Mr, Vice-Chancellor, Sir, you can readily see a spectrum of recurring terminologies, concepts and definitions of Mathematics depicting its varied perspectives and understandings. And some of these disclosures are that"Mathematics is a science, a language, a global activity, an art, a system of thought, a landscape, and a comforter for the invisible soul."Therefore, there is no repudiating that no other single discipline has as much universality as Mathematics in terms of the many different perspectives and definitions that are articulated about it.

While I agree with all or most of what has been said so far, I define ***Mathematics as the Intelligencer that unravels the hidden truths of everyday living derived from solving problems of environmental, scientific, and technological concerns using abstract representational systems and computational terms under realistic conditions!***No doubt, when Mathematics is applied to the real world, the most important thing is not whether it represents the complicated mathematical techniques, but does it tell something worthwhile or meaningful about reality? This is the question Mathematics tends to answer, and that's why, there's no gainsaying that Mathematics connects to every other discipline by way of the mathematical formulations, reasonings and interpretations.

In the words of Chike Obi (1975) he asserted that: "Any fool can be a diplomat and babble in the United Nations but requires some innate superiority to invent a thermionic value.” We can only reach this "innate superiority" by bringing together the talents of our brightest brains in the disciplines of Science, Technology, Engineering and Mathematics. This recalls the potent word 'Development,' which according to Amagh Nduka (2010) has four motive elements: Politics, Science, Technology, and Economy. He said, “*…the four fused into one by covalent bonds: The technology is dictated by the science, the economy by the technology, the politics by the economy, and the science by the politics; this is the magic wand. Africans' awkward predicaments and misery will persist so long as they fail to understand this.*”

Today, the developmental bedrock of America and China, for example, are hinged on STEM, collectively derived from Science, Technology, Engineering and Mathematics. To sum it all, Mathematics stands as the weaving fabric connecting political, scientific, technological, and economic ideas to proffer solutions to address the situations plaguing our environment.

Vice-Chancellor, Sir, Mathematics is a “Beautiful Bride,” and needs an applaud at this point!

3. Usefulness of Mathematics

Mathematical concepts emerge frequently in everyday life, and at first look, they may appear absurd. Mathematics is a tool for problem-solving!This is a must-have tool in a world where responses and nonlinear effects prevail. Therefore, Mathematics serves as a veritable tool of applications to almost every other discipline and its profession is noble so much so that it integrates all and the society, though highly dreaded! Mathematics is the bedrock of science and technology, and where there is no science and technology, there is no development.

Please, look around, can you see Mathematics? Even the auditorium we are using for the Inaugural Lecture is standing as a result of Mathematics. Whether we're aware of it or not, we all employ Mathematics in our daily lives. For thousands of years, and for many more to come, Mathematics has served as the universal language of our environment, assisting humans in explaining and creating within it. No wonder Matiki (2014) while exploring the "The Mathematical Precision of the Bible" puts it this way:

> "*As a discipline, Mathematics plays an interpretive role of explaining, revealing the hidden beauty of numbers and their patterns which are inherent in nature. It does so through non-refutable axioms, properties and theorems. The truth in the axioms,*

theorems and properties remain coherent to the point that Mathematics is considered as the language of creation for the scientist who is studying the laws of gravity or the geometry of chromosomes."

"Boundless Mathematics: The Novelty of Applications to Life and Panacea to Living" highlights the myriad hidden uses and applications of Mathematics in everyday life, from the most basic to the most complex. According to SIAM, "Mathematics matters, Apply It" described a campaign that raised awareness of Applied Mathematics for everyone interested in learning more about the Mathematics that underpins our daily lives and the technologies we use."This is Mathematics," Portuguese Mathematician, Rogério Martins in ICM (2018) gave the remarkable admiration that "there are connections between Mathematics and practically everything." For a more relatable side of Mathematics, Rogério Martins "believes that Mathematics is part of our human heritage." And this implies that the "applications of Mathematics are Boundless" because the discipline of Mathematics is seen in everything around us.

I want to state here that "Mathematical equations don't mean ANYTHING if they leave out applications!"A list of the everyday uses of Mathematics will confirm the "Boundless Mathematics: The Novelty of Applications to Life and Panacea to Living."

3.1 Automated Teller Machine (ATM)

ATMs are self-service banking terminals that enable customers to make quick cash withdrawals, deposits, bill payments, and account transfers. These computerised bank machines rely on two arithmetical operations: Addition and Subtraction amidst other hidden algorithms, which are used for 'secured operations.' Provided you can recognise the digits 0 – 9, then you can conveniently use a four-digit pin (for example, Union Bank) or either a four or five-digit pin depending on the amount (for example, First Bank), which is randomly selected for safe operations.

3.2 Cooking and Baking

There is no gainsaying that the Cook, Housewife or Chef needs some level of arithmetic in Mathematics to make a delicious soup. A combination of the ingredients in the right proportion to achieve the desired taste is guaranteed to involve Mathematics! What about a Baker? The mixing of various condiments with the right measurements and proportions gives you the name a Baker per excellence when the taste meets the desire of the consumers.

3.3 Tailoring

Every person here in this auditorium is putting on clothes. To sew well-fitting suits, trousers, shirts, skirts, and dresses, the tailor and fashion designer apply measurement, symmetry, and proportion principles in Mathematics.

3.4 Crowd Control

To restrain or contain the emotions of people, some level of Mathematics is used. For example, the feeding of the approximately 5,000 men stated in the Bible in Luke 9:14-15: "*For they were about five thousand men. And he said to his disciples, Make them sit down by fifties in a company. And they did so, and made them all sit down.*" The rest is history that they were all fed successfully.

3.5 Catching Fish

With the rising global demand for fish, a greater knowledge of what causes fish populations to expand or decline in abundance is required. Mathematical models help comprehend population swings. Analysing these simple models can help fisheries be harvested more sustainably. No wonder, the statement by Jesus in Luke 5:1-7: *"...Launch out into the deep, and let down your nets for a draught."* that brought about the net-breaking and boat sinking miraculous catch of fishes, was mathematically directed.

3.6 Exploring the Handiworks of God

After contemplating on several facets of God's creation, the Psalmist calls out in Psalm 104, "*O Lord, how many and varied are Your works! In wisdom have You made them all; the earth is full of Your riches and Your creatures.*" (Psalm 104:24 AMP). Mathematics is applied to describe the handiworks of God. For example, Mathematics helps us explore waves all around us. Sines and cosines, as well as the number pi (π), were most likely taught to you in school. The great thing is that these tools allow us to describe waves of all kinds, from ocean waves to light waves to particle waves inside atoms... wave-like equations, in particular, are utilized to describe the particles that make up our bodies' atoms. We observe God's wisdom, care, and faithfulness as we use Mathematics to investigate His creation (including Algebra and Calculus).

3.7 Recreational Purposes

Recreational Mathematics is a catch-all phrase for Mathematics done for fun rather than as a professional activity. These are mathematical games that cuts across well-known topics such as fractals, logic puzzles, Magic squares, and chess. Recreational Mathematics likewise embraces aesthetics and culture of Mathematics, stories that are weird or entertainingrelating to Mathematics, and personal lives.

3.8 Attorneys

Using fundamental decision theories, probability and logic, our learned friends, attorneys (lawyers and judges), step by step improve their arguments and make optimal-choiced-decisions in court to gain a greater grasp of the problem at hand.

3.9 Medical Doctors and Nurses

Medical doctors and nurses employ Mathematics daily while delivering care to patients all around the world. They make prescriptions for patients using basic statistics and probabilistic views to identify the nature and cause of disease, as well as an understanding of disease prevalence and incidence in epidemiological investigations.

3.10 X-Ray Crystallography

X-ray crystallography allows scientists to "see" physiologically vital molecules that are too tiny to be seen by even the most advanced light microscopes. The structure of a molecule can reveal a lot about how it works to construct your body, provide energy, keep you healthy, and more! The Mathematics behind is Wave equations, Fourier transforms, Coordinate Geometry, Statistical

Analyses.

3.11 Carpentry and Joinery

Mathematics is used extensively for different aspects of Carpentry and Joinery. Geometry, Symmetry, Algebra, and Measurement are among the basic Mathematics required to build roof rafters, stairs, angle measurements, and fine furniture.

3.12 Welding and Fabrications

Basic Mathematics knowledge of Geometry, Construction of measurements, Algebra, Linear and angular dimensions are used in Welding and Fabrication of doors, construction of driers (fish and meat), protectors and what have you.

3.13 Bankers and Accountants

Basic Mathematics skills in simple and compound interests and arithmetic processes are widely applied in the day-to-day jobs of Financial Managers, that is, Bankers and Accountants. It must be emphasized here that Mathematics and Banking are closely connected in that while Banking is a world of numbers, Mathematics is the pedigree in keeping track of every financial transaction for precision and accuracy in the Banking Industry. To say the least, Banking will not and never be Banking without

Mathematics! Some by-products of Mathematics highlighting its importance in the banking industry include mental alertness, accuracy, transparency, hard work, efficiency, measurable, accountability, tenacity, integrity, confidence, spirituality.

3.14 Internet and Phones

Mathematical equations have been shown in studies to make Internet communications via computers, mobile phones, and satellites much faster and more secure (W1). Mathematics gave birth to computers. Words, e-mails, graphics, music, photos, the results of database queries, and other data are represented by binary numbers, which are transferred as strings across the Internet using alphabets of 0's and 1's. So, messages or information are concealed utilizing a code or cipher in Mathematical statements using Combinatorics and Number Theory. This is the art of Cryptology.

3.15 Cryptography (or Cryptology)

The science and art of creating and transmitting coded signals is known as signal coding. Cryptography is a branch of Mathematics that combines combinatorics and number theory to securing or breaking coded messages. Its main purpose is writing'unreadable' or difficult keys that are only known to the intended recipient or devise means of breaking the code. Today, e-banking, e-commerce, e-learning, e-money (example, e-Naira) and all forms of web communications are in invoke. Without internet security, which depends on Cryptography, all the e-trading could not have existed.

Military science makes extensive use of encryption algorithms. The book "Why We Struct," (Ademoyega, 1981) written by former Nigerian Army, Major Adewale Ademoyega, gives a simple, but very unthinkable code. The book revealed that "on January 13, 1966, Major Ademoyegasent a coded message (telegram) from Lagos to Major Kaduna Nzeogwu in Kaduna," which reads:
"Major Ademoyega will leave Lagos after forty-one days holiday and will arrive in Kaduna after fifty-one days."

The message turned out to mean something in an uncoded language, which reads:
"The coup would take off on the night of the 14th and continue into the morning of the 15th."
"The rest, as they say, is history," since the date of January 15, 1966, represents a watershed moment in Nigeria's political history.

As a result, let me underscore that many security theories can be viewed as natural mathematical progressions. This is especially true in cryptography, where Graph theory, Number theory, Game theory, Probability theory, and Logic are only a few of the mathematical techniques employed.

3.16 Vehicle Routing

The consideration of all costs and externalities is required when applying sustainability principles to the implementation of urban freight strategies (Grosso et al., 2018).This is known as Vehicle Routing Problem. The problem of Vehicle Routing in Public Transportation and otherwise employs the Mathematics of Combinatorial Optimization and Integer Programming, whose purpose is to discover the best route for a fleet of vehicles carrying goods or services to distinct destinations. A very common example is Google Maps.

3.17 Predicting Traffic

Accurate traffic models could be used to pinpoint traffic causes and forecast traffic volumes. These models could aid in the development of better road and highway networks, as well as the identification of the best driving routes from a starting point to a destination depending on changing traffic conditions. To anticipate traffic, Differential Equations (Ordinary, Partial, Delay), Cellular Automata, Monte Carlo simulations, and Bifurcation studies are used.

3.18 Web Search Engines and Network Coding

Algorithms for Web Search Engines (e.g., Google, Safari, Bingo, Opera Mini, Mozilla Firefox, etc) use the Mathematics of Linear Algebra that studies linear equations, such as linear functions, as well as their matrices and vector space representations. They are widely used in Network Coding that has several applications in "5G communication systems, the Internet of Things (IoT), software-defined networks (SDN), content-centric networks (CCN)." Other applications are found in "repercussions on distributed storage solutions"that use mathematical equations.

3.19 Pattern Formation

Some technical terms used in Pattern Formation are Turing instability, Reaction-diffusion, Stability analysis, Diffusion Morphogens, Periodicity. Many chemical interactions lead to the discovery of practically periodic patterns. These patterns could be used to explain how animals like zebras, tigers, fish, and giraffes acquire their unique patterns. Stripes in dunes, tree bark patterns, and human fingerprints might all be explained by the same theory. Jacob in Genesis 30:32 – 39 used Pattern Formation known as Selective Breeding to populate his flocks and depopulate that of Laban his father-in-law. Mathematics is Everything!

3.20 Facial Reconstructive Surgery

In the planning of facial reconstructive procedures, Mathematics is vital. The goal of facial reconstructive surgery is to address bone characteristics of the skull for both functional and aesthetic reasons. This is done in software environments that combine patient-specific functional prototypes with partial differential equations for elastomechanics, fluid dynamics, or diffusion, as well as quick numerical solution and image processing techniques.

3.21 Magnetic Resonance Imaging (MRI)

Magnetohydrodynamics (MHD) has a variety of biomedical uses, including MRI. "MRI is a non-invasive medical imaging technology that uses nuclear magnetic resonance to provide high-resolution images of soft anatomical systems such as the brain, heart, ligaments, and eyes." This is an important known method for identifying hale and hearty tissues or organs from those that are diseased. Blood flow imaging and measurement, as well as functional neuroimaging based on dynamic changes in magnetic susceptibility, are two applications for which MRI offers exceptional potential. MHD controls or directs fluid flow to tissues or organs in any desired direction.

3.22 Sociology

Mathematical methods are used in sociology to investigate "society, human social interaction, and the laws and procedures that bind and separate people as individuals, as well as members of associations, groups, and institutions."This is simply known as "Mathematical Sociology."Sociology uses mathematical models and computer simulations of complicated social processes regularly. The mathematical ideas of graph theory, game theory, linear algebra, set theory, and probability are all significant in sociology.

3.23 Economics

Mr Vice-Chancellor, Sir, mathematical equations and methods find their uses in economics. The tools used in economics in expatiating their theories make use of differential and integral calculus, graph theory, algebra, mathematical programming and computing methods, which are far beyond fundamental geometry. Theoretical relationships can be expressed with rigour, generality, and simplicity, according to proponents of Mathematics. Economists can use Mathematics to develop meaningful, testable hypotheses about a wide range of topics that are difficult to convey verbally. This is the field of

Mathematical Economics.

3.24 Music

The study of pitch, time, and organization in music is known as music theory. It studies pace, chord progression, shape, and meter in music using mathematics. Set theory, Abstract algebra, and Number theory have all been applied to music in the endeavour to structure and express new ways of making and hearing music.

3.25 Art

Mathematics and Art are intertwined in numerous ways such that Mathematics has been referred to as a"Beautiful Art." Music, dancing, painting, architecture, sculpture, and textiles are all examples of Mathematics in the Arts. Mathematics and Art have a long and illustrious history together.

3.26 Nature

Mathematics is seen all around us. The Fibonacci sequence has long captivated mathematicians, artists, designers, and scientists. The Golden Ratio, due to its widespread application and exceptional utility in nature, suggests that it is a basic aspect of the Universe. Examples abound such as DNA molecules, animal bodies (e.g., zebras), fingers, flower petals, seed heads, pinecones, tree branches, human faces, etc that exhibit the Golden Ratio (1.6803...). The mathematical Fibonaccian process is seen in all these examples, and points to the fact that the Fingerprint of God is on all things! That's the reason the Golden Ratio is simply tagged “The Divine Beauty of Mathematics,” for it appears naturally, uniquely and universally appealing.

Mr. Vice-Chancellor, Sir, many of the challenges and opportunities confronting citizens in the 21stCentury necessitate some level of mathematical proficiency, resulting in a plethora of new and fascinating study topics. Some obvious examples include business optimization problems, household budget management,assessing political candidates' economic policies and proposals, and, of course, the never-ending drive to assemblethe liveliest fantasy sports squad possible, and if you don't win your local football league, at least do well enough to avoid embarrassments! As important as these examples are, there are a host of more mathematical applications taking place all the time all around us.The list of such applications is endless! Endless indeed! So, “Mathematics is everything,” and everything is all about Mathematics!Oh yes, “Boundless Mathematics!!”

4. Branches of Mathematics

Over time, Mathematics has encompassed a greater variety and depth of fields, necessitating a method to categorize and arrange the different subjects into more general domains of Mathematics. Several distinct classification methods have emerged, and while they have some similarities, they differ according to the various goals they serve. Furthermore, as Mathematics develops, these classification schemes must evolve to account for newly generated domains or newly discovered connections between them. Some subjects, often the most active, cross the line between multiple domains, making classification more challenging.

Mathematics is basically separated into two categories: Pure Mathematics and Applied Mathematics. Pure Mathematics is primarily concerned with its intrinsic interest, i.e., it is not motivated by applications to real-world problems. It is centred on abstract concepts and ideas. However, today that notion has changed in that areas in Pure Mathematics which are so far regarded as "Impregnable Pure" has increased variety of applications. Control Theory and the study of large-scale systems, for example, employ Algebraic Geometry; Economics uses Combinatorics and Graph Theory; Physics uses the Theory of Fibre Bundles; and Error-Correcting Codes uses Algebraic Invariant Theory.

Consequently, rather than being focused on substance, the difference separating Pure and Applied Mathematics is generally believed to be based on the level of motivation of the Mathematician. On the other hand, Applied Mathematics is concerned with solving issues in the actual world. This is the branch of Mathematics that uses its concepts, intuition and methods in researching in the domains of the environment, engineering, and business just mention a few. Applied Mathematics is a field of study that focuses on the construction and analysis of mathematical models in order to solve real-world problems (EB).Eric T. Bell once said:“One service Mathematics has rendered the human race. It has put common sense back where it belongs, on the topmost shelf next to the dusty canister labelled 'discarded nonsense.'”

5. The Uniqueness of Applied Mathematics

Mathematical methods utilized in science, engineering, business, computer science, economics, industry, politics, and society are all covered under Applied Mathematics. The development of mathematical theories has been driven by practical applications. As a result, Applied Mathematics and Pure Mathematics are intricately intertwined.

6. Fluids and their Connections to Applied Mathematics

Fluids, which are substances that flow easily, tend to take on the shape of their vessels. Liquids, gases, plasmas, and other similar substances fall within this category. Fluids are ubiquitous, and it is easy to recognize their presence and relevance in our daily lives: we drive, navigate, and fly inside fluids. Fluids are also responsible for the transportation of mass and heat, such as in the atmosphere, while fluids circulating within our bodies provide the foundation for cell life. Specifically, to mention just a few are fluids

- Used for Lubricants in Vehicles, Generators, etc (engine oils, gear oils, hydraulics, etc)
- We drink (water, soft drinks, honey, wine, coffee, milk, etc), wash, swim, and fish in waters of rivers, creeks, etc
- We cook with (water, vegetable oil, groundnut oil, olive oil, etc)
- Involved in transportation (petrol, gasoline, gas, water)
- Used in recreation (balloons, footballs, vehicle tyres and bicycles inflated with air)
- Used and generated in the comfort of our homes (from air conditions, fans, etc)
- Seen in Communication and Entertainment (GSM, sounds from speakers, TV sets, radio, etc)

- In the human body (blood, urine, sweat, etc).

Mr Vice-Chancellor, Sir, in "The Beginning," the creation of firmament (Heaven; Genesis 1:8) started with fluids (waters).

"And the earth was without form and void, and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters."(Genesis 1:2)

"And God said, Let there be a firmament in the midst of the waters…" (Genesis1:6)

"And God called the firmament Heaven." (Genesis 1:8)

"And God said, Let the waters under the heaven be gathered unto one place, and let the dry land appear: and it was so.

And God called the dry land Earth; and the gathering together of the waters called He seas…" (Genesis 1:9 – 10).

My understanding of the significance and nature of the Scriptures bring me to some symbolic arithmetic equations. The first in this Inaugural Lecture is from Genesis 1:9-10:

Waters (Fluids) + Earth = Firmament (Heaven). *(6.1)*

↓

Seas, Rivers, Channels, etc

Life on earth started with fluids:

"And the LORD God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul." (Genesis 2:7)

The second symbolic arithmetic equation of this Inaugural Lecture:

Man (formed from dust) + Breath of Life (Air i.e. Fluid) = Living Soul *(6.2)*

The third symbolic arithmetic equation of this Inaugural Lecture:

Flesh + Blood (Fluid) = Life *(6.3)*

is obtained from "For the life of the flesh is in the blood..." (Leviticus 17:11)

"*For it is the life of all flesh; the blood of it is for the life thereof…*" (Leviticus 17:14)

The fourth symbolic arithmetic equation of the Inaugural Lecture:

$$\textbf{Waters (Fluid)} + \textbf{Salt} = \textbf{Healed (Purified) Waters} \quad (6.4)$$

is obtained from II Kings 2:19-22.

Fluids are represented as continuous media, with their motion and conditions defined by velocity, temperature, pressure, density, and other parameters that may be measured in both space and time. The fluids (i.e., waters, air, blood) identified in the above scriptures are necessary test ingredients in the formulations and solutions of problems in Applied Mathematics.

7. My Footprints as Applied Mathematician

"Everybody is called to do SOMETHING, but no one is called to do EVERYTHING" – Christine Caine. What one is called to do makes one curious and that leads to specialization and specialization births intellectualism. And that brings me to Intellectual Curiosity!

Intellectual Curiosity is simply defined as putting theory to practice, which may be called experiential learning (Santa Clara University). Intellectual Curiosity has made me to have considered and used seven simple words, which have contributed so greatly to where I am today in academia. These are "*What, Why, When, Who, Where,* *How, If*." These words serve as incentives to thinking, and they are all interrogative or probing words that have brought me to the peculiarities of my academic pursuit via intellectual collaborations and writing and publishing articles in reputable Conferences, Local and International Journals and Books. This corroborates the words of the Holy Book:

"*Now go, write it before them in a table, and note it in a book, that it may be for the time to come forever and ever*:" (Isaiah 30:8)

"…*Take thee a great roll, and write in it with a man's pen*…" (Isaiah 8:1)

"…*Write the vision, and make it plain upon tables, that he may run that readeth it*." (Habakkuk 2:2)

"*Where there is no vision, the people perish: but he that keepeth the law, happy is he*." (Proverbs 29:18)

Let me at this point speak briefly on what I refer to as **Work-Life Equation** as seen from the Scripture:

"*Whatsoever thy hand findeth to do, do it with thy <u>might</u>, for there is no <u>work</u>, nor device, nor knowledge, nor wisdom, in the grave*..."(Ecclesiastes 9:10)

From the passage, <u>might</u> stands for power, capacity, strength, force or influence or ability to do **something**, and work means the “Endeavours," that is, our "Efforts" or "Strives" to achieve our objectives or goals in Work-Life. So, Work-Life is simply the portion of our lives that we spend and dedicate to work for professional attainment or to gain experience in something.

Therefore, the infused mathematical character, the Work-Life (WL) Equation from the passage is simply written as

$$WL = \int_a^b E(t)\, dt, \qquad (7.1)$$

where *a, b* and *E (t)* are the lower, upper bounds and Efforts, respectively. Integrating our Efforts with respect to time equals Work-Life. This implies that our Endeavours are equal in relation to the rate of change of our Work-Life with regards to the number of years we put into those activities. The Efforts (or Struggles) you encounter over time and how you choose to deal with and overcome them in the pursuance of your work objectives or goals defines your Work Life.

In other words, Work-Life may be a **Career Path**, which implies a set of employment roles that lead to your professional short- and long-term goals. In essence, a Career Path is the path you take to achieve your career objective or goals.

My research interests are hinged on the applications of Mathematics and Modelling to various systems in Engineering, Biology, Technology, and the Environment. Problems studied under these systems are categorized as in

- *Engineering*: Magnetohydrodynamic flows, Newtonian flows, Thermal radiation, Combustion processes and Chemical Kinetics.
- *Biological:* Blood Flow and Magnetohydro-dynamic Convection in Channels.
- *Technological*: Heat transfer in Fins, Fuel Spray penetration.
- *Environmental*: Water Quality and Pollution Transport in Rivers, Channels and Seas - Reaction, Advection, Diffusion of solutes.
- *Others*: Boundary layer flows, Construction reliability and Detection of Structural defects, Singularly perturbed systems, Dynamic photoelasticity, Determination of hydraulic parameters.

The peculiarities of the Inaugural Lecture are categorized as in the following different sub-titles:

7.1 Boundless Mathematics: The peculiarities of MHD

MHD is simply defined as the study of the kinematics of an electrically conducting fluids with magnetic fields. The fluid dynamics equations are combined with the Maxwell's equations of electromagnetism to form the physical mathematical framework of MHD. Some applications of MHD are found in

- Drug targeting in medicine and design of MRI and ECG medical equipment
- Nuclear reactor liquid - metal cooling, electromagnetic casting and plasma confinement
- Flow rate measurements in food processing industries
- Flows in boundary layers in aerodynamic field
- Accelerators, centrifugal solid-liquid separation, crude oil purification, astrophysical fluxes, the earth's interior, the ionosphere, and the stars in the fields of Geophysics and Astrophysics
- Electric power generators such as dynamo, motor, fusion, reactors, flow meters in Engineering

These examples as well as others in the literature (Hughes and Brighton, 1967; Branover, 1978; Sharma and Chaudhary, 2004; Qian and Bau, 2009), provide an excellent overview of MHD-based microfluidic device developments and applications.

The following are the governing continuity equations, the equations of motion (momentum) of an incompressible viscous and electrically conducting fluid in a porous medium, the energy equation, and the concentration of species equation:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{v}) = 0, \quad (7.1.1)$$

$$\rho \left[\frac{\partial \boldsymbol{v}}{\partial t} + (\mathbf{v} \cdot \nabla \mathbf{v}) \right] = -\nabla p + \mu \nabla^2 \boldsymbol{v} + +\mu \boldsymbol{J} \times \boldsymbol{H} - \frac{\mu}{k} \boldsymbol{v} + \rho \boldsymbol{F}, \quad (7.1.2)$$

$$\rho c_p \left[\frac{\partial T}{\partial t} + (\mathbf{v} \cdot \nabla \mathrm{T}) \right] = \kappa \nabla^2 T - \nabla \cdot \boldsymbol{q}_r \pm q''' + \Phi, \quad (7.1.3)$$

$$\rho \left[\frac{\partial c}{\partial t} + (\mathbf{v} \cdot \nabla \mathrm{c}) \right] = \rho D \nabla^2 c \pm r_c, \quad (7.1.4)$$

$$\nabla^2 \boldsymbol{q}_r - 3\alpha^2 \boldsymbol{q}_r - 16 \alpha \sigma T_\infty^3 \nabla \cdot T = 0, \quad (7.1.5)$$

with the constitutive relations:

$$\boldsymbol{J} = \sigma_c (\mu \boldsymbol{v} \times \boldsymbol{H}), \boldsymbol{B} = \mu \boldsymbol{H}. \quad (7.1.6)$$

Here v denotes the fluid velocity vector, ρ the density, p the pressure, t the time, $\boldsymbol{F}$ the force (per unit mass) that may include viscosity terms and any external forces such as gravity, μ the constant coefficient of (dynamic) viscosity, k the porous medium permeability, $\boldsymbol{J}$ the electric current, σ_c the electric conductivity, $\boldsymbol{H}$ the magnetic field, $\boldsymbol{B}$ magnetic induction vector, c_p the specific heat at constant pressure, T temperature, κ constant thermal conductivity, $\boldsymbol{q}_r$ radiative heat flux vector, q''' internal heat sources or sinks, Φ dissipation function, c species concentration, D the diffusivity constant, r_c the reaction term (production or loss, Soret effects, etc.), α the mean absorption coefficient, σ Stefan-Boltzmann constant, ∇ an operator, and ∇^2 the Laplacian. Equations (7.1.1) – (7.1.5) are only solvable when the right initial and boundary conditions are applied with some simplifying assumptions. Some key terms used in the research of MHD are

Free Convection: This is the transport of fluid contents, such as mass or heat, by currents created in the fluid by a buoyant force that is reliant on an acceleration (such as gravity) acting on density variations in the fluid caused by mass or heat. The rising of smoke particles from a fire, the draft of a chimney caused by a fire in a fireplace, and the transmission of heat from a hot object via upward hot air currents from the object are examples.

Double-Diffusive Convection or Thermo solutal*:* Is a transition process that experiences simultaneous heat and mass transfer mechanisms with the occurrence of temperature and species concentration differences in a medium or between media with a coupling of one on the other. Examples of thermal engineering applications are found in thermal insulation, oil extraction, groundwater pollution, etc. The term "buoyancy-induced flows" has been used many times (Rubin and Atkinson, 2001).

Thermal Radiation*:* This is an energy process obtained from a heated surface or source that generates the motion of charged particles. It is also referred to as an electromagnetic radiation.

Heat Transfer: This is simply described as the branch of physics that studies energy transfer between material things as a function of temperature differences. This energy is classified as heat according to thermodynamics. Let me discuss some of my specific contributions in MHD and related areas:

7.1.1 Combustion Processes and High-Temperatures

Predicting the elements that regulate combustible material thermal ignition is crucial in many industrial processes. Combustion is an exothermic, fast-moving process. As a result, the reaction moves swiftly and is non-isothermal once it is started. No doubt, combustion processes produce a lot of energy such as IC engines, furnaces, and fires, and they are highly used in heat generation, power production, and incineration activities. Combustion processes are difficult in general due to the involvement of complicated kinetics, mass transfer control, and high-temperature variations. In combustion calculations, hundreds of reactions might be considered, but only the most significant reaction mechanisms whose rates are measurable are only selected. A simple example of hydrogen oxidation reaction:

$$2H_2 + O_2 \rightarrow 2H_2O$$

gives a straightforward combustion reaction. This process is exceedingly complicated, with 38 reaction steps involving eight different species in the conventional model (Schmidth, 1998; Chung, 2002).

Further examples of combustion processes are found in hypersonic planes and re-entry vehicles, nuclear processes, geophysical and astrophysical applications (Ghoshdastidar, 2004), petroleum sector gas flares and compressors in ships (Abowei and Sikoki, 2005). Thermal radiation created by the flare is one of the performance parameters of relevance in the petroleum sector for concerns about waste-gas and emission safety (Peterson et al., 2007). This buttresses the importance of the study of radiation in combustion processes.

It is known in non-isothermal chemical reactions that nonlinearities abound, which are not experienced in non-reacting systems (Schmidt, 1998). This explains the nonlinearity of the emerging equations that are used to simulate chemically reactive combustible flows. In such equations, the sensible enthalpy is linked to chemical species, which adds to the heat source and diffusion of species interacting with the temperature (Chung, 2002). As a result, the solutions to the developing equations are examined computationally most of the time. Approximate, perturbative, integral, and ad hoc solutions to these nonlinear equations are only employed to gain physical insights due to highcost of computational resources.

Vice-Chancellor, Sir, we have successfully examined several problems in combustion processes and high temperaturesthat are found worthy in literature. Mebine (2007) used the "Laplace Transform to solve the problem of MHD flow with radiative heat transfer past an oscillating plate in a thermosolutal state."Using an analytical method, Mebine (2007) investigated "the influence of thermal radiation on MHD Couette flow with heat transfer between two parallel plates."Mebine (2009) exploited the nonlinearity appearing in the governing equation of "thermally radiating fluid flow and constructed integral solutions."

Mebine (2009) proposed a solution to "thermosolutal MHD flow and radiative heat transfer over a vertical porous plate with viscous work and a heat source" using a regular perturbation technique. Mebine and Gumus (2010) used a "global approximation to develop approximate solutions for MHD thermally radiating and reacting thermosolutal viscous flow over a porous medium channel." Mebine (2010) proposed a"WKBJ approximation solution to deal with the thermally radiating effect in substantially exothermic processes with generalized Arrhenius kinetics." These rough solutions can help you understand the physics and chemistry at the heart of the problems.

7.1.2 MHD Free Convection Flows with Sources/Sinks

The studies of MHD free (natural) convection flows coupled with thermal radiation and or mass transfer under different physical conditions have several applications in cosmology and astrophysics, geophysical dynamics, solar physics, meteorology, and re-entry programs. The flow problems arisingare solved using Laplace transform technique validated by numerical solutions (see Israel-Cookey et al., 2002; Mebine &Adigio, 2011).The results revealed that increase in the magnetic and radiative parameters both dampens the flow, while the heat transfer rate is increased by reduction both in magnetic and radiative parameters, thereby physically signifying that these parameters could be used as cooling agents.

There are many MHD pulsatile flow applications in biomechanics, biophysics, physiology, and medical engineering, such as hemodynamics and MRI technology (Misra et al., 2010), blood dialysis in artificial kidneys (Esmond and Clark, 1966), "blood flow through an artery, peristaltic food motion in the intestine, and urine motion in the urethra" (Berman, 1958; Wang, 1971).Mebine and Ebiwareme (2017) investigated "MHD pulsatile flow via a porous channel with heat generation" using air, water, and human blood as test fluids. The findings revealed the oscillatory character of pulsatile flows, as well as the fact thatincrease in the Prandtl number that measures the ratio of momentum and thermal buoyancy forces, lowers the flow and temperature in the channel's fluid.

7.1.4 MHD Flows in the Boundary Layer

The modelling of MHD boundary layer flows have been examined under different physically realistic and compatible conditions (Battacharyya et al., 2014). Mebine (2014) used "von Karman integral boundary layer method to explore the MHD dynamic boundary layer slip flow model."The findings accurately described the non-equilibrium zone near the solid-fluid interface. The results are important in microfluidic devices such as in micro-electromechanical systems, and where slip condition arises whenfluids like emulsions, suspensions, foams, or polymer solutions slides across the surface of a dynamic or static solid encapsulated in a particulate fluid.

To further buttress the all-important slip flow condition, Mebine (2015) also examined the MHD slip boundary layer flow by applying a series technique known as Successive Differential Coefficients (SDC) in handling the problem. The findings confirmed numerical estimates and expanded the application of Pade approximations in "MHD velocity slip effected Blasius problem." The flow is controlled by damping when a magnetic field is applied.

7.2 Boundless Mathematics: The peculiarities of Environmental Fluid Modelling

Environmental fluid modelling encompasses a comprehensive spectrum of subjects. The various involvements in this area are environmental transport processes, hydrodynamics, and hydrology with the resultant pollutant processes from physical, chemical, and biological activities in relation to the pollutant sources and origins, fate, dispersion, and degradation, transport, deposition, and accumulation, and their attendant effects on human health and environmental quality.

Our main concern is on water quality modelling that lies in the determination of some physical transport mechanisms that aid the transport and mixing rates that enhance the reduced concentration of unavoidable wastewater discharges in the natural or coastal waters. Concentrations of dissolved substances (especially solutes), various chemical pollutants, salinity, temperature, biological species, and other parameters of interest are typical examples. The following are some basic definitions of several often-used transportation words:

Advection: Rivers, streams, and tidal motions are examples of motions related to mean flow or currents. They are commonly conceived of as essentially horizontal motions and are usually caused by gravity or pressure forces.

Convection: This term mainly relates to hydrostatic instability-induced buoyancy-driven vertical motions. We experience this whenever we are heating a pot of water on the stove, for example.

Molecular diffusion: Brownian motion occurs when molecules in a fluid move randomly relative to other molecules, resulting in the mixing or spreading of fluid properties. This is in line withthe second law of thermodynamics.

Turbulent diffusion: This is a type of mixing similar to molecular diffusion, but with a far larger influence. In this circumstance, turbulent eddies cause mixing due to the larger-scale movement of fluid packets (rather than individual molecules).

Shear: This is the differing of advection at different points in a flow field. It is also known as a velocity gradient. As the advective rate of a fluid property fluctuates so does the average concentration of that property.

Dispersion*:* This is the combination of the effects of both shear and turbulence spread in a fluid property.

Knowledge about individual sources and sinks reaction terms, as well as interactions with other species, are included in the basic mass balance equations of dissolved mass to properly characterize the destiny and movement of a given species. Our interest lies in the study and analyses of the transport of dissolved mass of a tracer in natural or coaster waters. The governing steady-state depth-averaged mass continuity and reaction-advection-diffusion equations, respectively, are written as follows:

$$\nabla \cdot (hc) = 0 \quad (7.2.1)$$

$$h\lambda c \pm \nabla \cdot (huc) - \nabla \cdot (h\kappa \nabla c) = 0 \quad (7.2.2)$$

where $h(y)$,the water depth; $u(y)$, the vertically averaged velocity and ∇ the horizontal gradient operator (∂_x,∂_y). The crossflow dependent scalar diffusivity $\kappa(y)$, i.e., the cross-flow mixing rate, $c(x,y)$ depth-averaged concentration of a reactive pollutant with first-order temporal decay rate $\lambda(y)$, and (x,y) are the horizontal and cross-flow co-ordinates, are used to describe the dilution process. The equations (7.2.1) and (7.2.2) are solved together with the appropriate boundary conditions with turbulent shear power-law scales for $\kappa(y)$, $u(y)$ and $\lambda(y)$ as in Mebine (2006).

The equations (7.2.1) and (7.2.2) are applied to analyse steady contaminant discharges in rivers using several flow parameters in straight channels and sloping beaches with different depth profiles such as flat, linear and exponential depth profiles by the use of analytical, numerical and direct simulation methods of solution. The centre point of my PhD research was on those simplistic seemly unimportant equations (7.2.1) and (7.2.2) that one can readily ask, “Can any good come from those equations,” just like the jaded words of Nathanael in John 1:46: “*Can any good come from Nazareth?*” Let me examine some valuable contributions I have made to appreciate the usefulness of those equations in the transport analyses of contaminants in river systems.

7.2.1 The Concept of MEID for Water Quality Management (Mebine, 2006)

MEID stands for "Minimum Environmental Impact Discharging," which implies "optimal mitigation procedures in alleviating water quality impairments and the ecological effects of discharging contaminants into river environments." The investigations employed mathematical models of depth-averaged variable coefficients reaction-advection-diffusion equations (7.2.1) and (7.2.2) validated by numerical techniques to explain fluctuations in pollutant concentrations.The properties depicting rivers, viz, width, depth, and velocity are not constant by nature in real river flows such that they grow downstream. The mathematical models representing the transport of contaminants via rivers are more complicated than they appear in equations (7.2.1) and (7.2.2). As a result, it's unsurprising that many simplifying assumptions are used in mathematical models of pollutant movement in rivers.

Despite their economic values to man and aquatic life, rivers serve as garbage disposal systems, as evidenced by the ongoing discharge of oil, chemical, and biological wastes into them. Is it then important where and what is released into rivers?MEID responded to these concerns by proposing approaches for optimum pollutant transfer in rivers for "moderate discharges that do not change the flow in a non-branching straight section of a river."

Therefore, the formulations and implementations of rational policies for river management include tactics to minimize potential environmental impacts by ways of optimal strategies to avoid, mitigate, or at least initiate corrective measures of the pollutants. As a result, determining and clarifying the physical mechanisms that result in defining

- Contaminant attenuation in steady discharges,
- the “Mixing or Diffusion Centre of a channel for optimal discharges,”and
- “Optimal strategies to promote environmentally friendly pollutant transport”

are some needed ingredients for river managers.

The major purpose of MEID was to develop mathematical principles and computer programmes for direct computations of the “best discharging sites” of rivers while accounting for the “effects of variability in pollution loss processes.”

7.2.2 Steady Discharges in a River (Mebine & Smith, 2004)

A regular basis in favour of steady low-level discharges is to reduce high-level waste-water discharges. This is the main objective of modern large-scale sewage works and industrial operations. The selection of a precise discharge location further reduces the environmental impact. Minimizing excessive coastline concentrations is a strategic managerial policy to safeguard these economically important places due to their diversified plant, fish, and animal communities in these near-shore or littoral zones (Smith, 1982). Mebine and Smith (2004) demonstrated "magnitude of avoidable shoreline excesses for the illustrative cases of conserved and non-conserved solutes discharged at a constant rate from a single location into a channel with a water depth that rises from zero to maximum on the right side (Figure 7.2.1)."

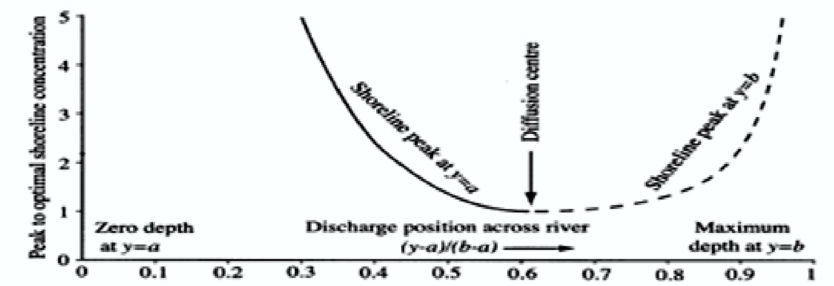
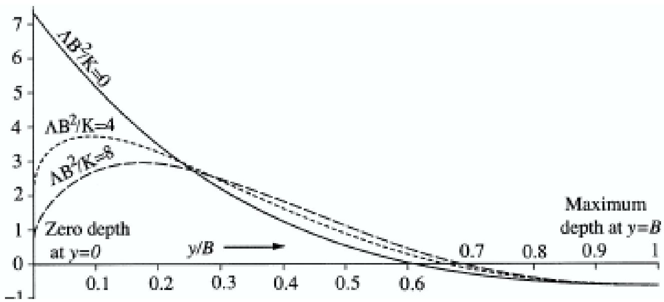


Figure7.2.1: "Magnitude of shoreline pollution," (Mebine & Smith, 2004)

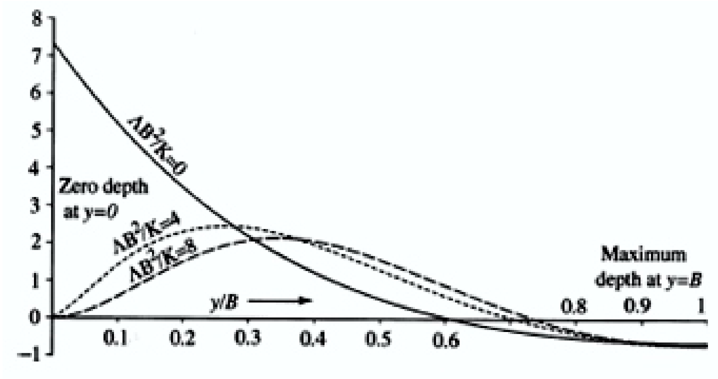
7.2.3 Mixing or Diffusion Centre of a River (Mebine & Smith, 2006)

The optimal or best discharge site of a river that minimizes shoreline concentrations of pollutants is known as "Mixing or Diffusion Centre."Mebine and Smith (2006) investigated the "diffusion centre for steady discharges in a non-symmetric river with non-reversing flow with pollutant decay effects: radioactive decay, consumed by bacteria, heat loss or evaporation through the surface, dissolution by turbulence." Whittaker function exact solutions were presented using pollutant mode method to demonstrate the impacts of contaminant decay.The results indicated that as the "temporal decay divided by flow speed decreases or increases with water depth, the diffusion centre shifts towards deeper or shallower water." Figures 7.2.2–7.2.4, as well as Tables 7.2.1–7.2.3, are included for clarity.



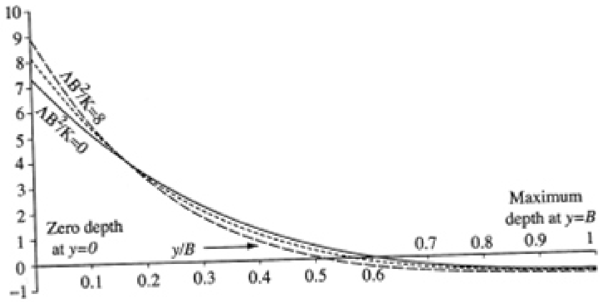
AB^2/K	y_1/B
0	0.608
2	0.637
4	0.657
6	0.673
8	0.685
10	0.696

Figure7.2.2 and **Table7.2.1** for "optimal discharge positions for constant decay with linearly increasing depth," (Mebine & Smith 2006; Mebine, 2006).



$\Lambda B^2/K$	y_1/B
0	0.608
2	0.676
4	0.705
6	0.723
8	0.736
10	0.747

Figure7.2.3 and **Table7.2.2** for "optimal discharge positions for decay that decreases with depth,"(Mebine & Smith 2006; Mebine, 2006).



$\Lambda B^2/K$	y_1/B
0	0.608
2	0.589
4	0.568
6	0.544
8	0.518
10	0.489

Figure7.2.4 and **Table7.2.3** for "optimal discharge positions for decay that increases with depth,"(Mebine & Smith 2006; Mebine, 2006).

7.2.4 Computational models for steady discharges (Mebine, 2006; 2009)

In situations where analytical or approximate solutions are not feasible to the governing reaction-advection-diffusion mathematical models for forecasting the fate and transport of pollutants in real river systems, the next bet of solutions is via numerical experiments. Pollutant transport processes investigated in our research included three criteria: “the effluent being discharged (i.e., its physical, chemical, and biological transformations); the rate at which the effluent is discharged (i.e., the total mass of pollutant injected in a given time); the spacing and orientation of the discharge outlets (i.e., the height of the injection point above the outfall of the natural channel).”To account for the impacts of depth variability, flow, mixing, and decay, Mebine (2006; 2009) developed finite-difference, implicit numerical schemes. Benchmark test problems were employed to validate the numerical solutions such that the computational results offered accurate estimations as well as visual representations of the differences between discharging at non-optimal and optimal river sites, as well as concentration distributions.

Vice-Chancellor, Sir, the validity of our results enunciated and affirmed those in the literature (Smith, 1982, 2004; Giles, 1995; Mebine, 2006; Mebine and Smith, 2006). The overall testament once again is that the “Diffusion Centre” of a riverminimizes shoreline concentrations downstream, and that the “single zero crossing of the first advection-diffusion eigenmode” is the location of that point.The simple instances indicated that this position is skewed towards the channel's deepest region, indicating that contaminant plumes bend towards shallower water, and hence the discharge point should be positioned in deeper waters. The concentration contours shown in Figures 7.2.5-7.2.9 exhibit optimal and non-optimal discharges.

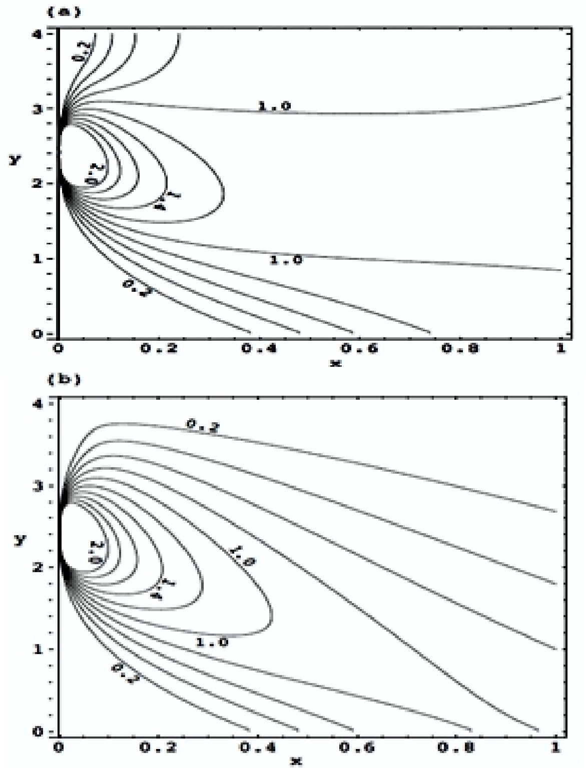


Figure 7.2.5: "Concentration contours for optimal discharge with (a) no-flux boundary conditions, (b) zero concentration boundary condition," (Mebine, 2006; 2009).

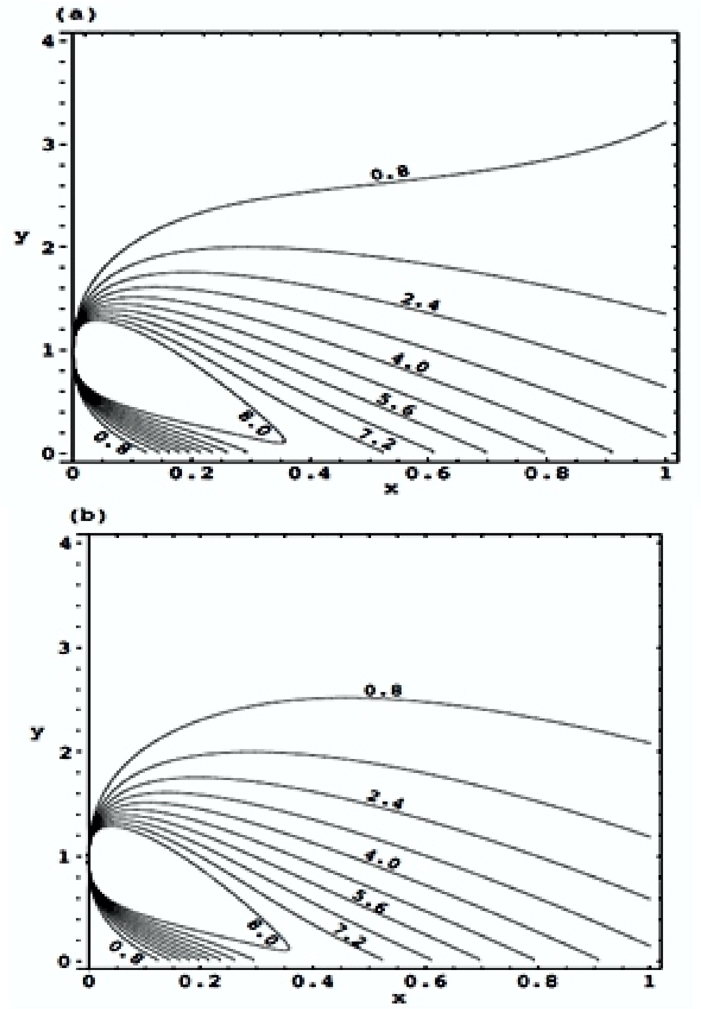


Figure 7.2.6: "Concentration contours of discharge (a) halfway below the midpoint discharge with no-flux boundary conditions, (b) halfway below the midpoint discharge with zero concentration boundary conditions," (Mebine, 2006; 2009).

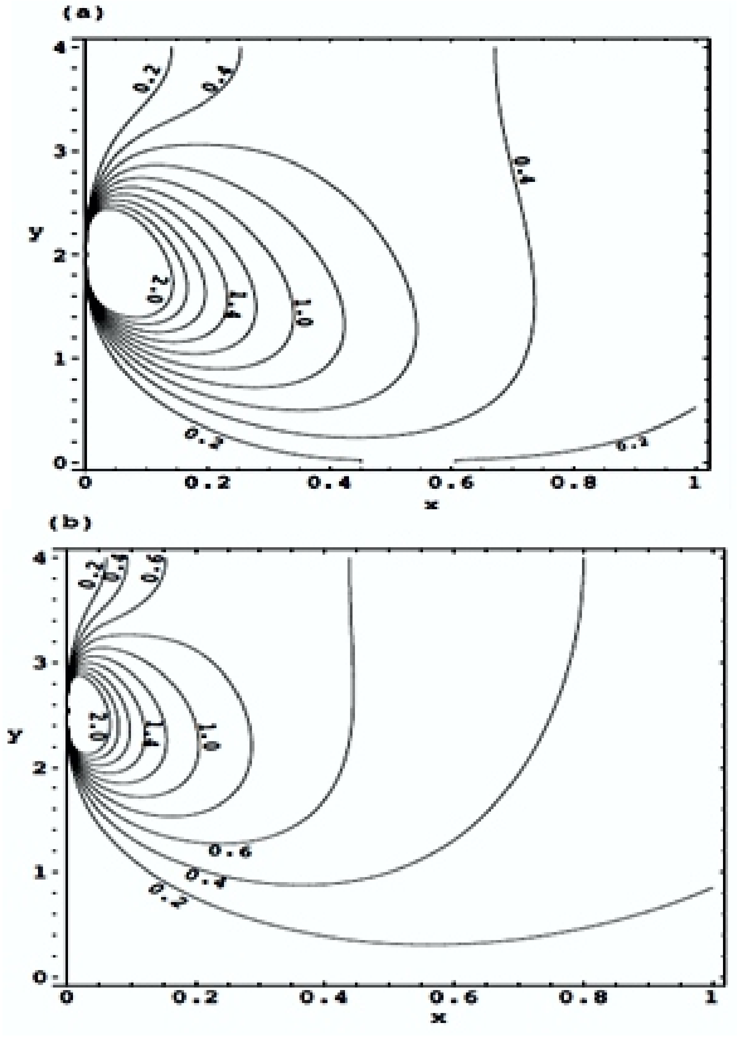


Figure 7.2.7: "Concentration contours for constant decay (a) midpoint discharge, (b) optimal discharge,"(Mebine, 2006; 2009).

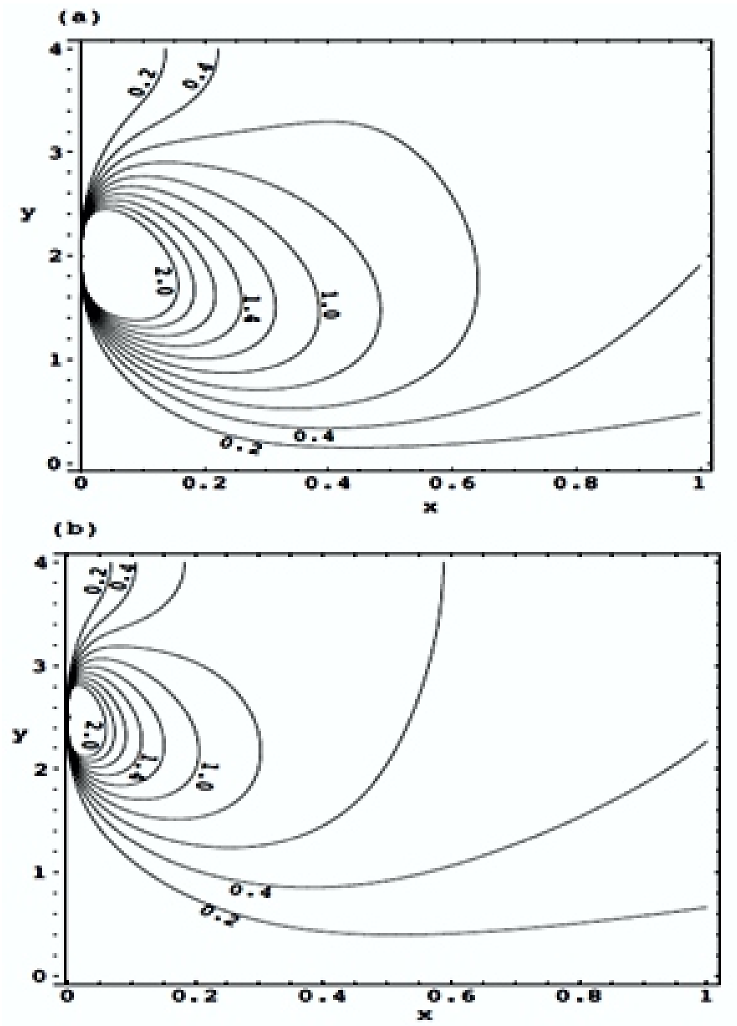


Figure 7.2.8: "Concentration contours for decay that decreases with depth (a) midpoint discharge, (b) optimal discharge,"(Mebine, 2006; 2009).

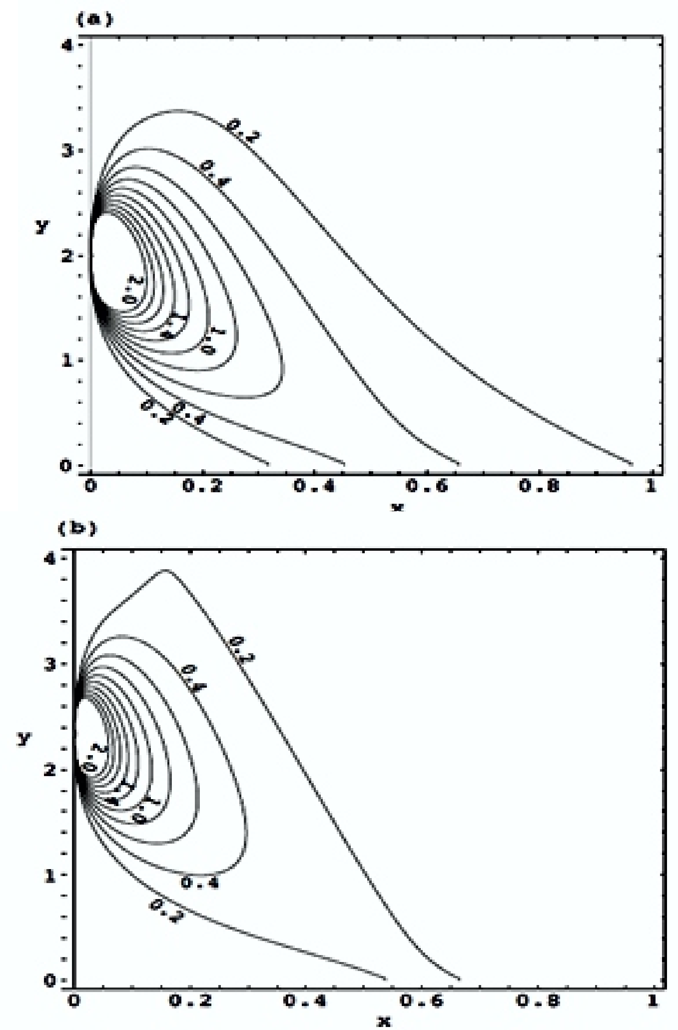


Figure 7.2.9: "Concentration contours for decay that increases with depth (a) midpoint discharge, (b) optimal discharge,"(Mebine, 2006; 2009).

7.2.5 Ray Curvatures and Concentration Distributions (Mebine & Smith, 2009)

The time scale for transverse mixing in navigable rivers might be several days. In such periods, sewage bacteria (Gould and Munro, 1981) and heat (MacQueen and Preston, 1983) deteriorate significantly. Exponential attenuation with downstream distance could account for degradation in a channel with the same depth and flow (Fischer et al., 1994). Different pollutants have different transverse degradation mechanisms in water of varied depths. The major processes that define the fractionation of pollutant concentrations are the flow rate, downstream discharge position, and cross flow mixing (Ho et al., 2002) for vertically well-mixed pollutant sand the different variable decay mechanisms (Mebine and Smith, 2006). For all vertically well-mixed pollutants, the flow and mixing are the same; decay rates and discharge strengths can vary.

Ray Curvatures are particular paths along which information is transmitted when advection outweighs diffusion. In defining these directions, decay effects are taken into account. For a smoothly increasing depth, Mebine and Smith (2009) obtained a "general result for the curvature of the rays as a function of spatial non-uniformity in decay, mixing, flow speed, and flow direction.”The nature of the contaminant ray curvature away from a point source depends on the “decay-diffusivity ratio” accordingly as it “increases or decreases with the water depth.” Sensitivity analyses indicate that decay makes curvature negative (shore-wards).Figures 7.2.10 - 7.2.12 demonstrate “ray trajectories and concentration contours for decay proportional to flow speed, decay to speed ratio that decreases with depth, and decay to speed ratio that increases with depth.”

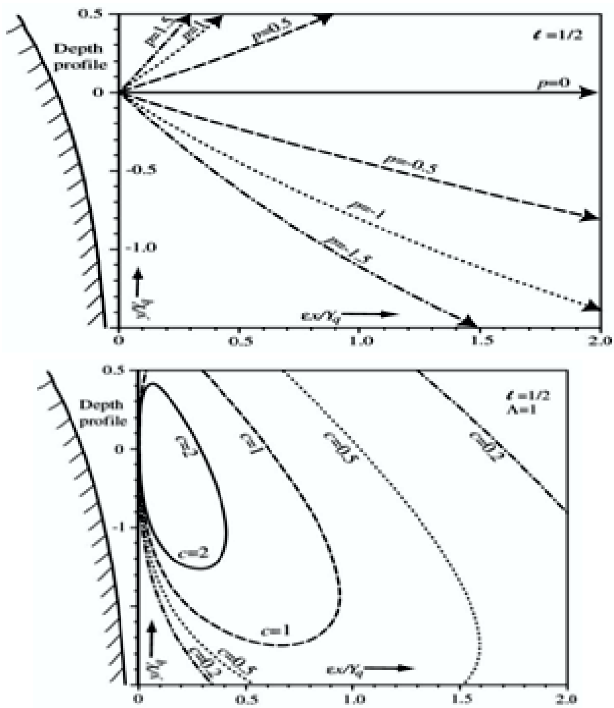


Figure7.2.10: “Ray paths and Concentration contours for decay proportional to flow speed,” (Mebine and Smith, 2009).

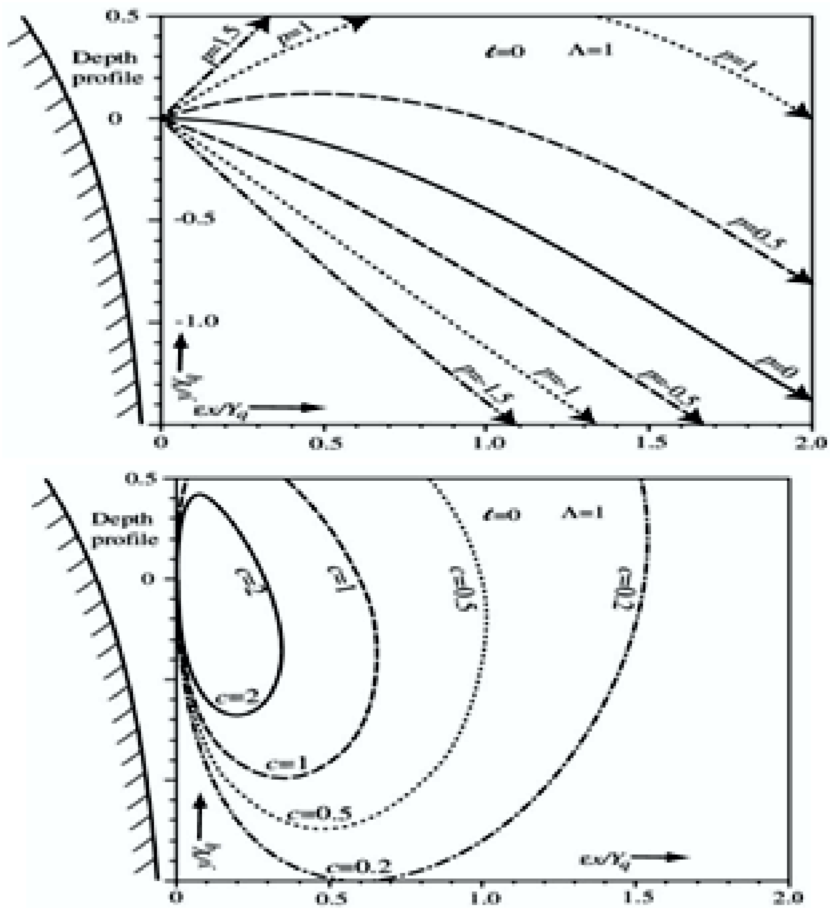
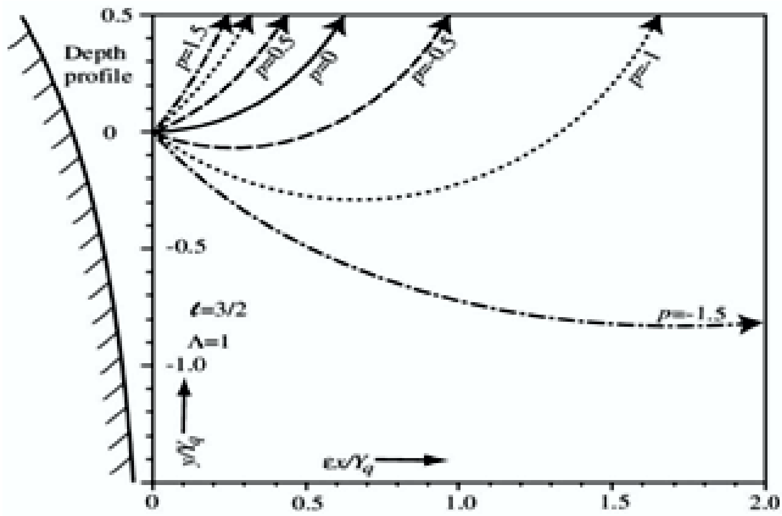


Figure7.2.11: "Ray paths and Concentration contours for decay to speed ratio that decreases with depth," (Mebine and Smith, 2009).



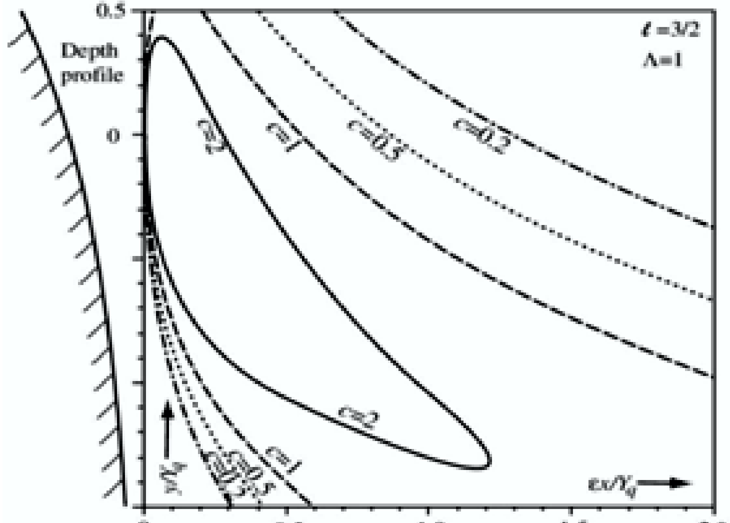


Figure7.2.12: "Ray paths and Concentration contours for decay to speed ratio that increases with depth,"(Mebine and Smith, 2009).

7.2.6 Effects of decay and depth discontinuity on steady discharges (Mebine, 2006)

Mebine (2006) explored "decay and depth discontinuities on steady discharges using a modified ray-tracing interpretation" of generalised Gaussian solutions to highlight the significance of a jump in decay. "Discontinuous variations in depth, diffusivity, velocity, and decay"(see Figure 7.2.13) made it possible to estimate the approximated incident, reflected, and transmitted rays (see Figure 7.2.14), decay-jump parameter M and concentration formulae with only two possible scaled ray patterns for the decay ($M<0, M>0$; Figure 7.2.14)with the appropriate "depth, diffusivity, velocity and decay power turbulent" scales. Ray bending suggests that contaminants are primarily propagated downstream in the low-decay region. Figures 7.3.15 and 7.3.16 depict this scenario.

Vice-Chancellor, Sir, the results validated those for "non-decaying solutes released from a point source in an idealized river with a depth discontinuity parallel to the flow (Kay, 1987)."

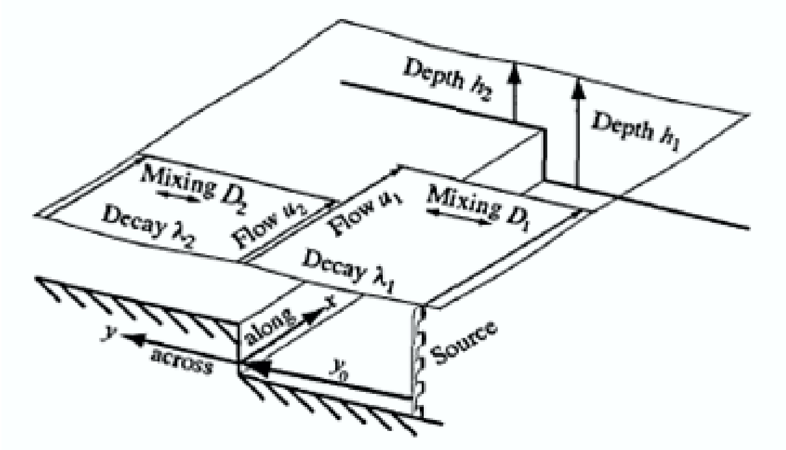
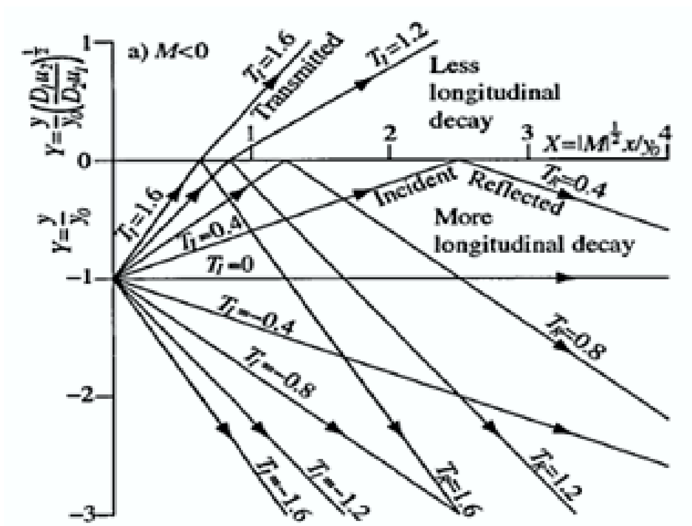


Figure 7.2.13: "Steady source discontinuous depth, diffusivity, velocity, and decay fluctuations," (Mebine, 2006).



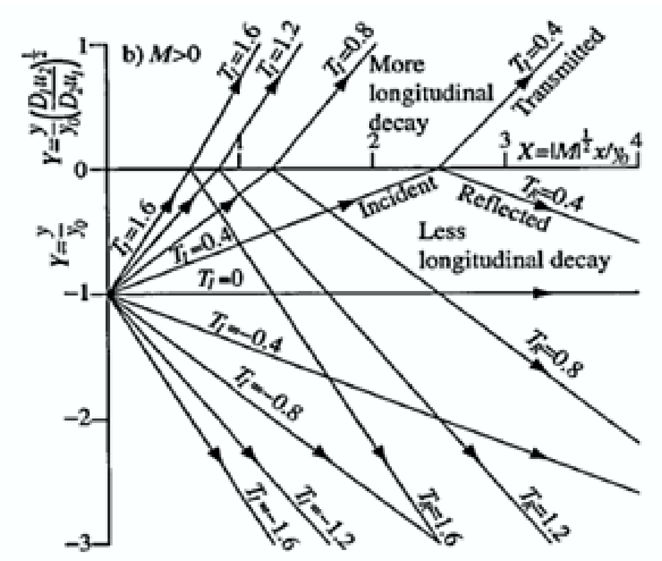
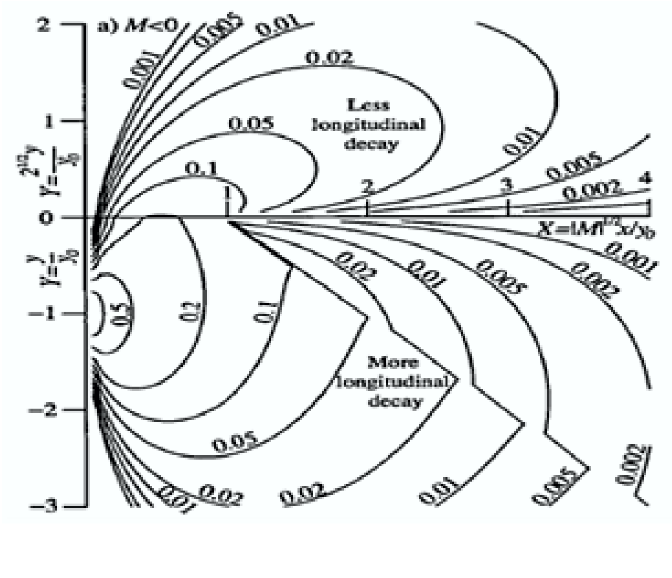


Figure 7.2.14: “Only two possible scaled ray patterns: a)



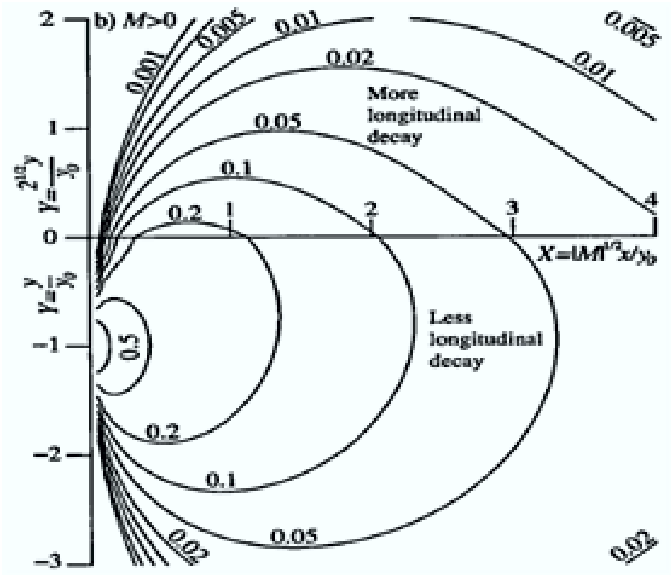
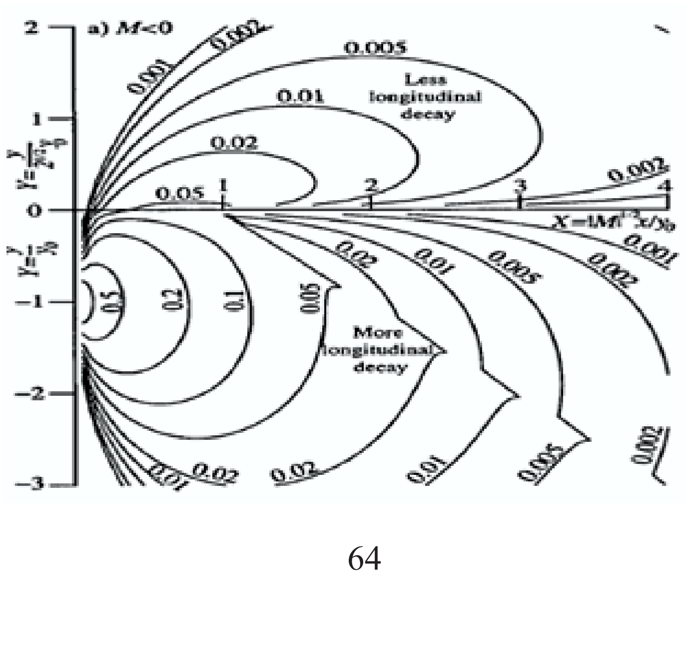


Figure 7.2.15: "Ray approximations to concentration to the half-depth far side,"(Mebine, 2006).



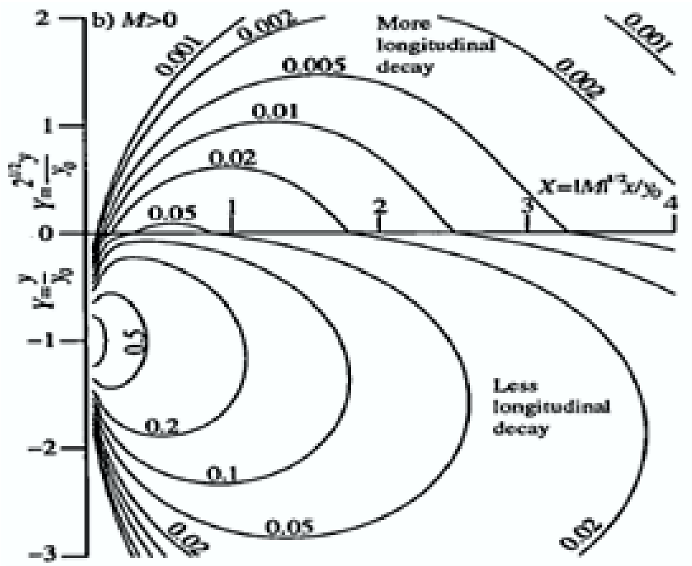


Figure 7.2.16: “Ray approximations to concentration to double-depth far side,”(Mebine, 2006).

7.2.7 Sloping Beaches and Coastal Waters

These are dynamic locations where land and sea meet physically. Characteristically shallow and sandy in some cases, but in other areas, they are rugged shorelines with steep sea cliffs where the waters swiftly deepen. They are recognized areas for fish catchments, conservation zones for their aesthetics and resort centres, as well as becoming key developing industrial and population hubs. Sandy beaches are popularly known vacation destinations where visitors can relax and swim. Despite these economic benefits, they are also used as effluent discharge areas. It is known that “bent-over effluent plumes” are observed moving “towards the shoreline”due to the shallow water depth of nearshore, potentially causing a build-up of contaminant concentrations to greater levels in coastal waters. To minimize the environmental effects of waste effluent discharges, marine outfalls are constructed (Roberts and Tian, 2004).

Sloping beaches or eroding seabeds are mostly due to erosion and sediment movements caused by waves, winds, storms, and rising sea levels (Pilkey and Cooper, 2004). The degraded materials are deposited and accumulates offshore or onshore, pending whether the erosion occurred in the summer or winter (Bruun, 1962). The main purpose is gaining insights about prescribing the regulatory requirements for sea outfall discharges to minimize contaminant concentrations in these environments. The mathematical modelling makes use of advection-diffusion equations with a power-law depth profile function (h) of distance y from the beach, $h=my^{n}$ $(n>0)$;$n \rightarrow 0$ (flat seabed);$n=1$ (uniformly sloping seabed);$n<1$(seabed erosion) (see Figure 7.3.17). For more understanding of the concepts, techniques and results see the references (Bleninger and Jirka, 2008; Purnama et al., 2011; Purnama et al., 2017).

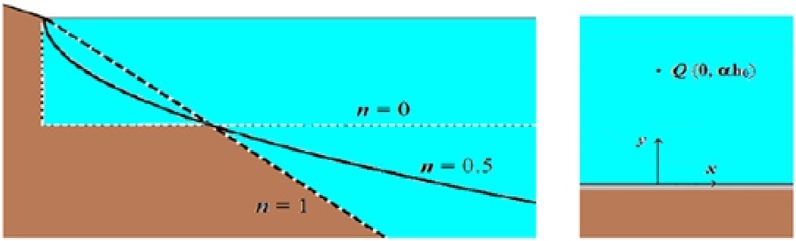


Figure 7.2.17: "Cross-section view of eroding seabed (left); and plan view of a single point source (right),"(Purnama et al., 2017).

Mr. Vice-Chancellor, Sir, the results of our investigations which agrees with those in literature indicated that

- the maximum shoreline concentrations are environmental impact measures that should not be exceeded anywhere along the beach,
- Seabed erosion increases the maximum concentration value, and
- maximum concentration value should be considered in prescribing regulatory requirements for sea outfall discharges (see Figures 7.2.18 – 7.2.21).

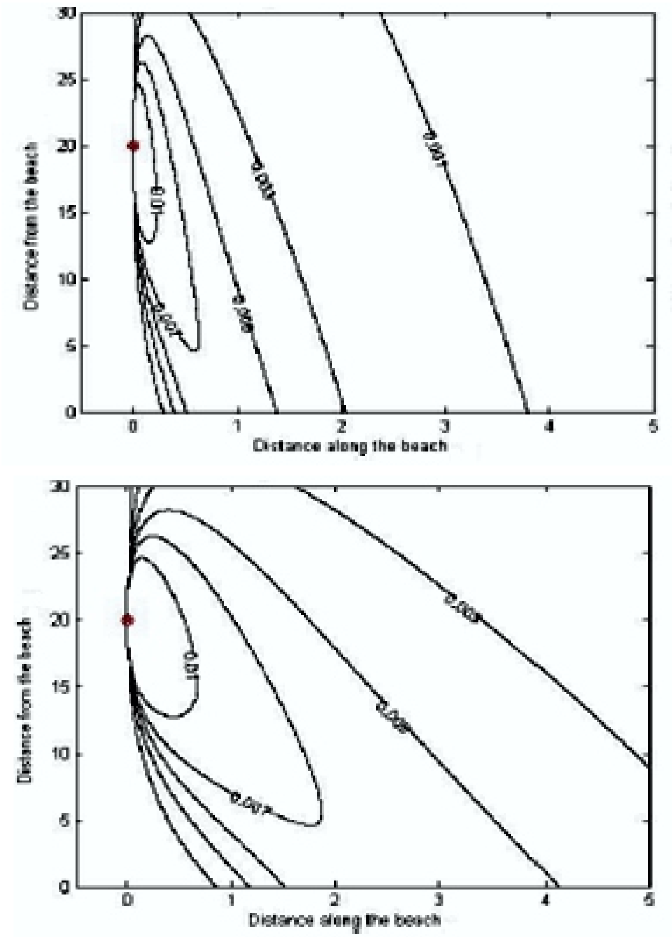


Figure 7.2.18: “Far-field effluent plumes on the non-eroding sloping seabed with a 20% difference in plume elongation parameter,” (Purnama et al., 2017).

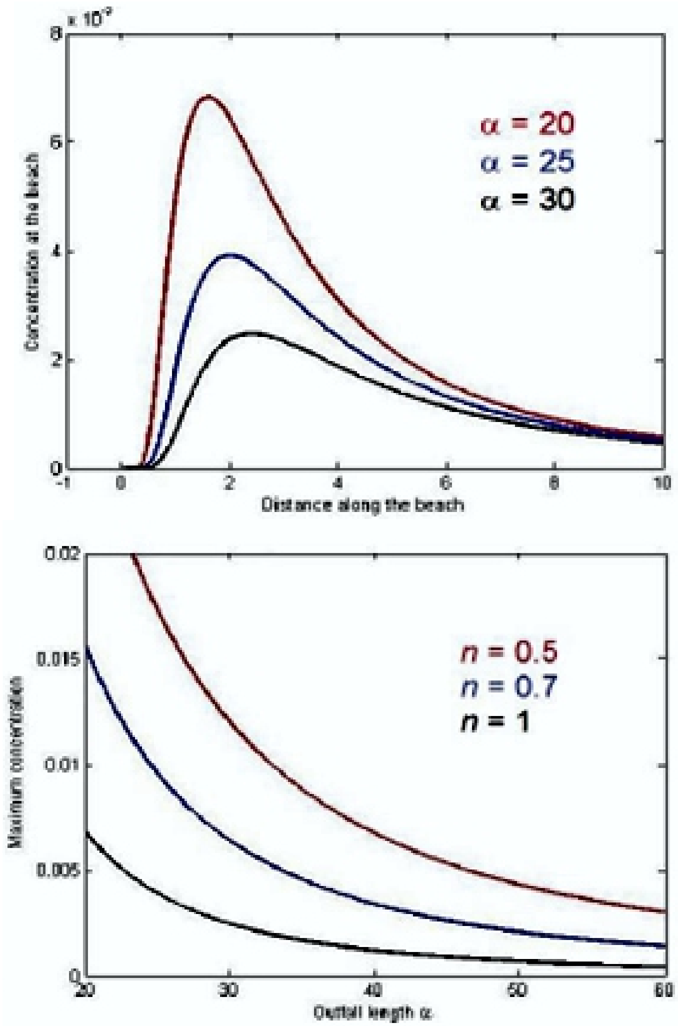


Figure 7.2.19: “Shoreline's concentration for a given plume elongation parameter (left), and maximum concentration values (right),”(Purnama et al., 2017).

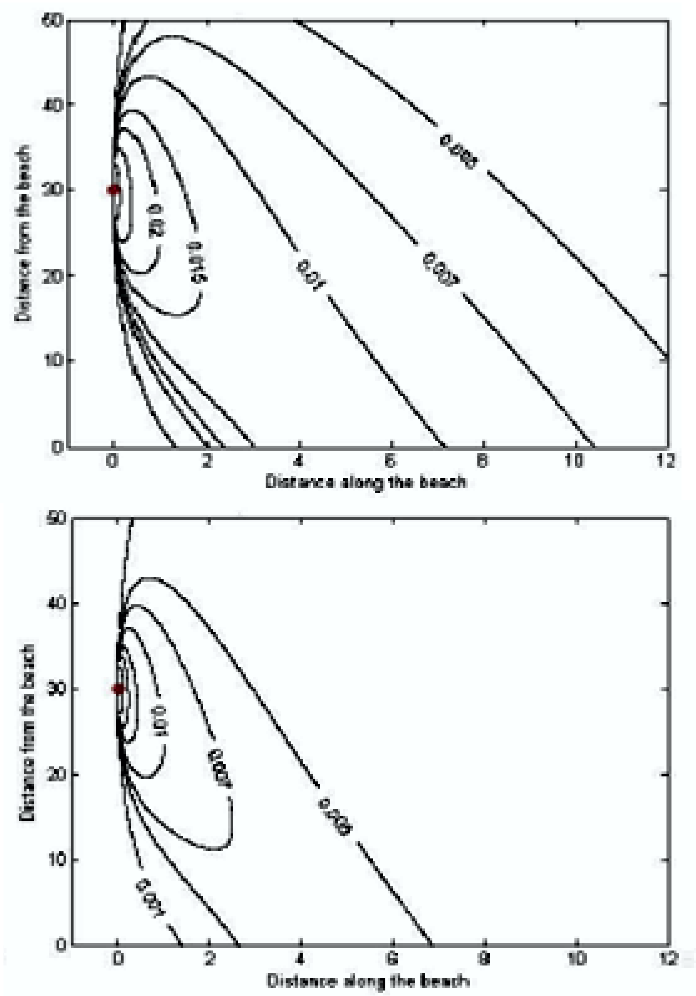


Figure 7.2.20: "Far field effluent plumes on two eroding sloping seabed profiles: n=0.5 (left), n=0.7 (right),"(Purnama et al., 2017).

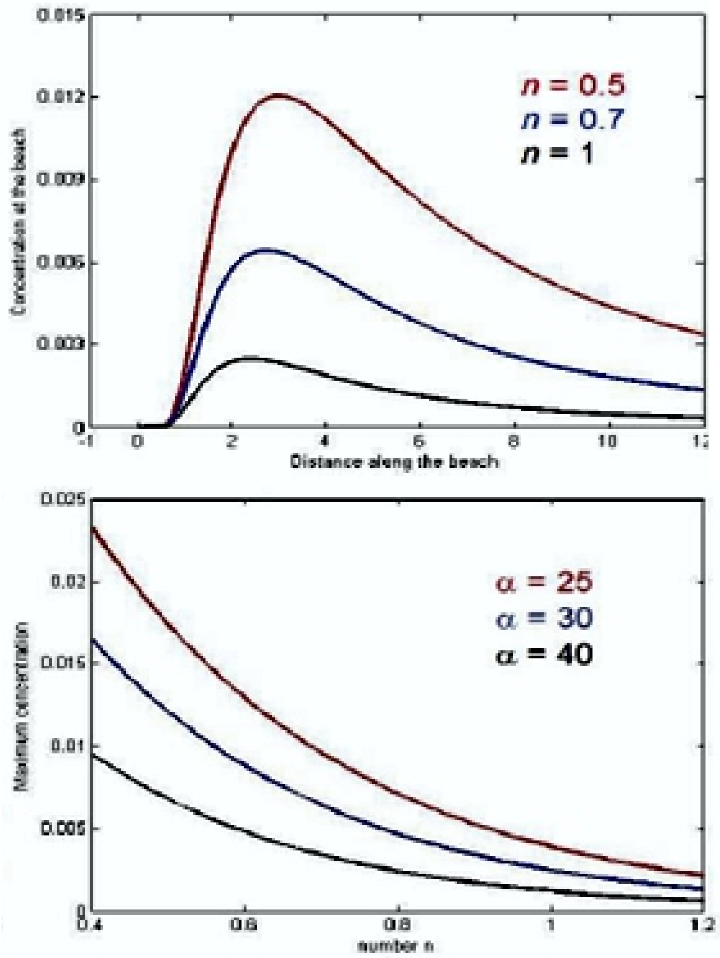


Figure 7.2.21: "Shoreline's concentration for a given plume elongation parameter (left), and maximum concentration values (right)," (Purnama et al., 2017).

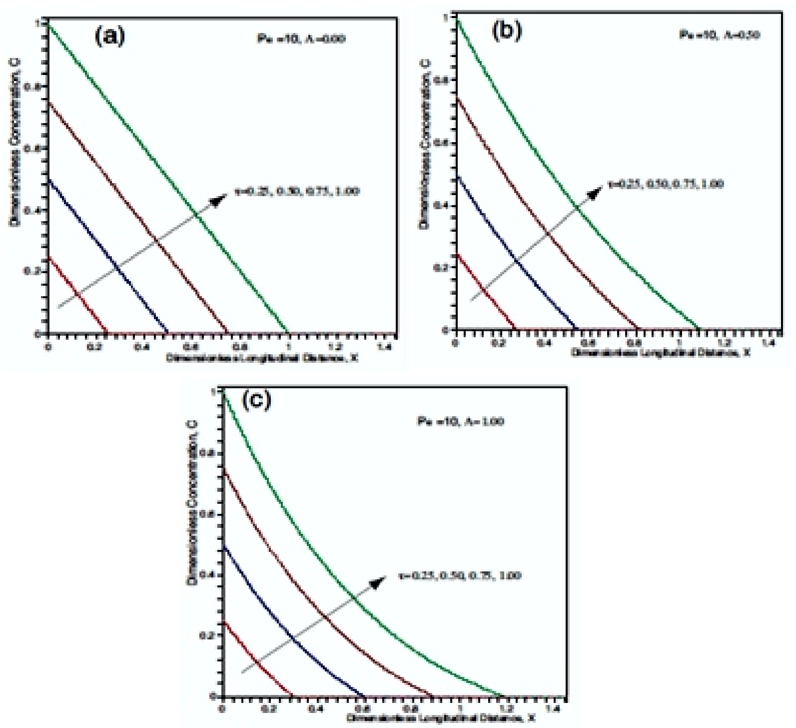
7.2.8 Time-dependent Contaminant Sources (Mebine & George, 2011; 2016)

The mathematical modelling of time-dependent contaminant sources has big impacts on contamination transports and plume distributions in streams or sub-surfaces. The obvious consequences are of "thermal effluents from cooling facilities, contaminant releases from chemical processing industries, and from several other agricultural, domestic, and industrial practices."

The main aim is to devise strategies in the modelling and to gain insights how best to regulate or mitigate the impacts (Dhar and Sinha, 1989; Mazumder and Dalal, 2000; Baverman et al., 1995; Kolditz et al., 1998; Sandrin et al., 2001; Sen et al., 2002; Serrano, 2001). Mebine and George (2011, 2016) investigatedrespectively analytical solutions via the Laplace Transformation technique and numerical simulations via COMSOL Multiphysics to longitudinal advection-dispersion of decaying contaminants for time-dependent sources. The economic goal was achieved via

- careful selection of time-dependent sources concerning the strength of mixing, advective and contaminant decay processes
- regular avoidance of downstream pollution levels.

The overall goal was that insights of low economic costs were gained to reduce downstream pollutants for intentionally polluted streams or groundwaters with non-conservative contaminants. Some pictorial representations were made to illustrate interesting features of the resultsas



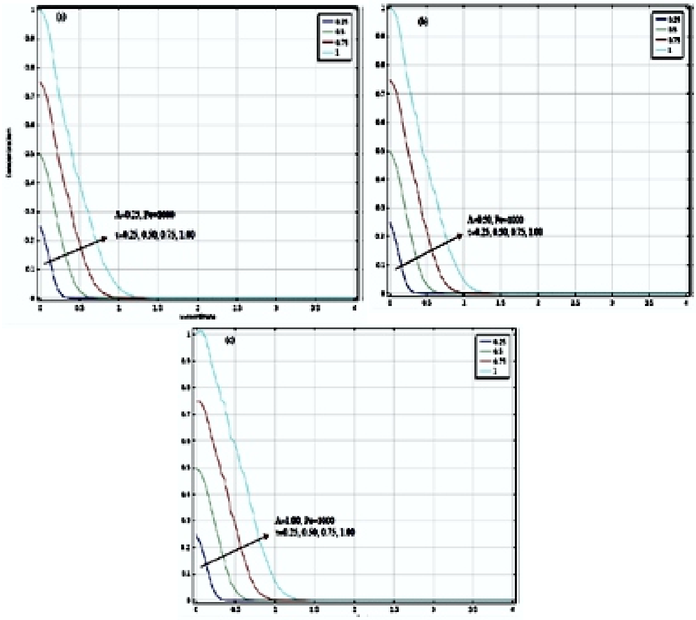
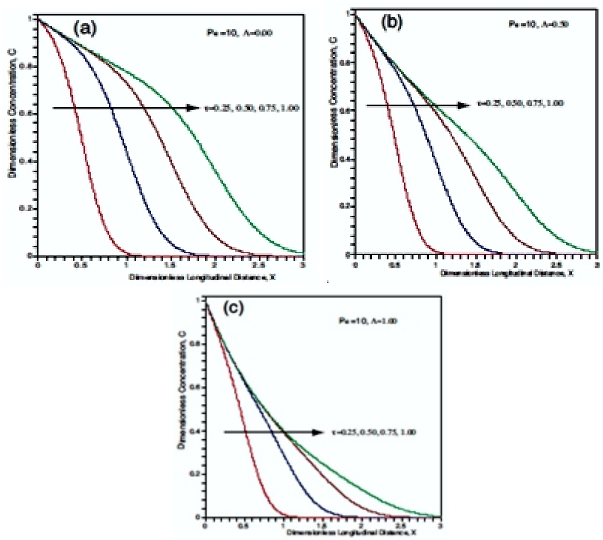


Figure 7.2.22: Analytical and Simulated Accelerated Source Concentration Profiles.



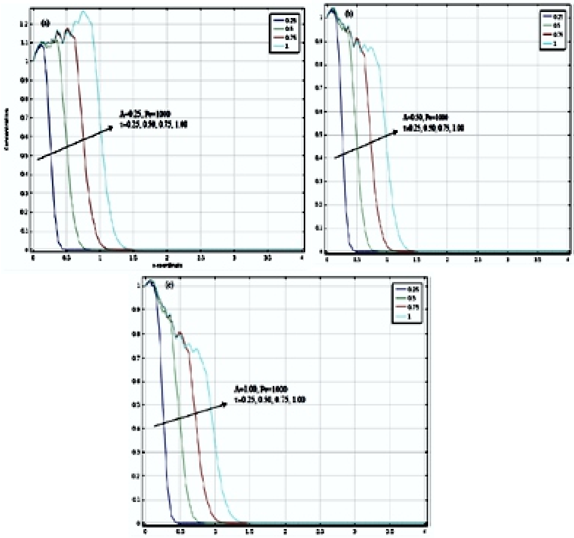
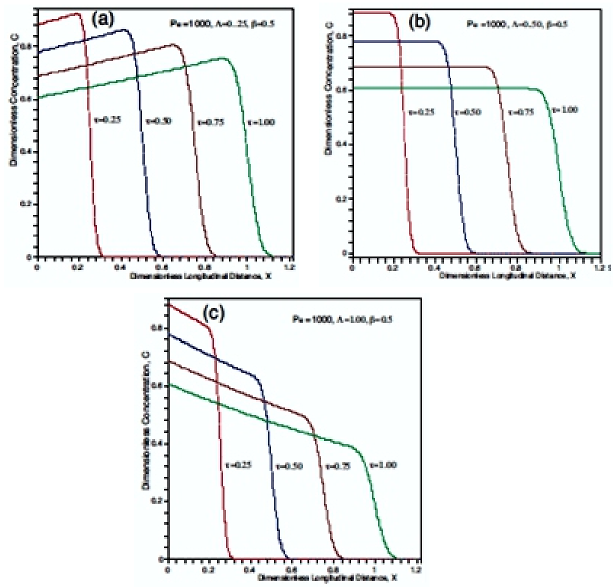


Figure 7.2.23: Analytical and Simulated Continuous (Impulsive) Source Concentration Profiles.



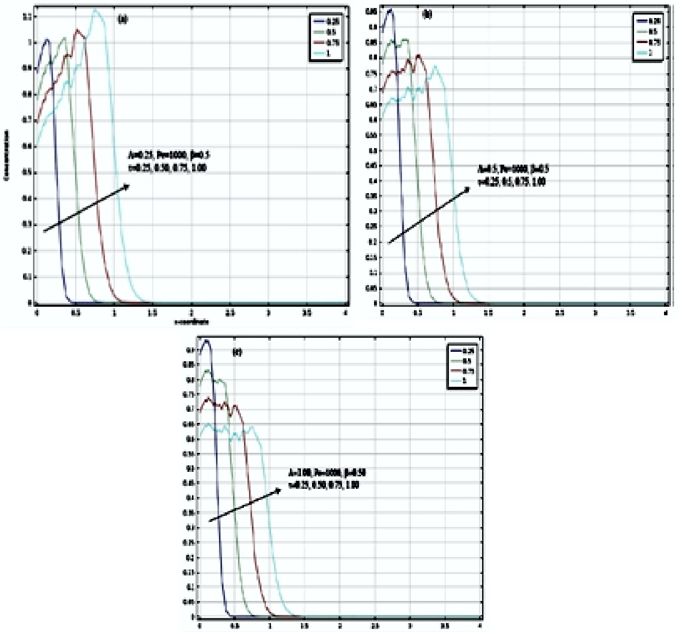


Figure 7.2.24: Analytical and Simulated Exponential Source Concentration Profiles.

7.2.9 Fuel Spray Penetration (Mebine, 2012)

It is known that the efficiency and thrust power of engines are influenced by fuel spray penetration (FSP). It is a critical factor that is found in all vapour distributions, air vapour mixings, and combustion chambers gas turbulence. Its varieties are seen in“agricultural sprays, sprays in boilers, diesel engines, gas turbines, and space rockets.” The flow regimes respectively found in FSP are “Stokes flow, Allen flow and Newton flow,” which are governed by separate differential equations. Mebine (2012) formulated a unified general equation to model the FSP problem, which was tackled with an effective approximate variational iteration method giving rise to a general analytical solution. The general solution validated the results that were solved separately and broadens the scope of comprehending the problem's fundamental physics, which is critical in industrial and technological domains.

7.2.10 Environmental Noise Pollution Assessment (Ogobiriet al., 2013; 2014)

The ability of humans to hear noise is seen as a significant advancement in human well-being. The level of aggravation caused by noise is determined by the individual's attitude and mood toward the noise, as well as the sound's quality and volume.

Noise, simply known as an unwanted sound is generated through endless ways such as in internal combustion engines, and heavy industrial machinery and processes. Avwiri and Nte (2003) stated that when discussing physical quantities, the word sound is preferred to using noise, which are frequently used interchangeably. Ogobiriet al. (2013) investigated noise levels from aircraft's noise at various locations in the Port Harcourt International Airport using field measurements that were accurately estimated and validated by a unique predictive mathematical optimization model.Ogobiriet al. (2014) studied the effects of noise levels in the communities constituting Yenagoa Metropolis using the combination of physical or acoustic measurements and social surveys via questionnaires. Also, Ogobiriet al. (2014) ventured into the investigation of noise levels caused by various sawmills in the Yenagoa Metropolis. In all, computer aided predictive models and statistical analyses were employed to validate the measurements for the inferences that gave insights into the revealed impacts of noise on the people such as headaches, lack of sleep and irritability.

7.3 Boundless Mathematics: The peculiarities of Technological and Other Applications

Please, permit me to emphasize, Vice-Chancellor, Sir, that many of the other significant contributions I've made can be put to good use in technology and allied sectors.

7.3.1 Unsteady Free Convection Flow (Mebine & Adigio, 2009)

Unsteady or time-dependent free convections flows occur regularly in “nature as well as in engineering and environmental applications.” The governing mathematical equations of momentum and energy involved incorporated physical parameters such as thermal radiation, porous media and Newtonian heating of the surface or the object the flow is passing through or over. Exact solutions were obtained using Laplace transform method. The results which were validated by numerical examples revealed the characteristics of the problem such that the boundary layer was controlled majorly by thermal radiation and suction parameters among other physical factors. Whereas the "boundary layer decreases for increasing thermal radiation (like suction effects), the boundary layer increases for injection or blowing."

7.3.2 Aquifer Hydraulic Parameters (Okiongbo& Mebine, 2014)

As common as water is in the Niger Delta, not every water is drinkable. It is also important to state here that the inability of the government to provide portable drinking water for the masses, has constituted the indiscriminate sinking of boreholes here and there. Particularly in the Yenagoa metropolis, private boreholes are littered all over the environs without resorting to laid down policies and standards. There are vital parameters which should be considered for groundwater protections and contaminant transport predictions (de Lima and Niwas, 2000) that are water transmitting qualities of a geologic formation, which include porosity, hydraulic conductivity, and transmissivity. These are significant criteria that supports the optimization and proper management of groundwater resources in any specific location (Ekine and Iheonunekwu, 2007). On this premise, Okiongbo and Mebine (2014) did investigation on existing boreholes to determine aquifer hydraulic properties in Yenagoa and its vicinity via vertical electrical sounding (VES) data using Dar Zarrouk criteria.

The indiscriminate drilling of boreholes in Yenagoa and its surroundings are precipitated on the fact that its location is found in the "transition zone of the Coastal Lowlands hydrogeologic province in Southern Nigeria, covered by a thick layer of sedimentary rocks." The assumption is that reliable source of high-quality groundwater would be found with ease without first conducting "geological, geophysical, and hydrogeological" investigations to assess the transmitting characteristics of the groundwater system.

Vice-Chancellor, Sir, the results of the investigation revealed that

- The paired electrical resistivity values to the neighbouring VES stations were indicative that the hydraulic conductivity and transmissivity changes at the VES locations,which were inferred using the resulting relationship and Dar Zarrouk characteristics.

- The overall findings were suggestive of an aquifer with fine-medium–coarse sands that were unconsolidated.

7.3.3 Singularly Perturbed Systems (Olali& Mebine, 2015)

In physics, chemical kinetics, neural networks, fluid dynamics, mathematical biology, pollutant dispersion in the atmosphere, and a variety of control theory models, singularly perturbed systems of equations are frequently employed as mathematical models. These problems are based on a small positive parameter that causes the solution to vary rapidly in some areas while remaining stable in others. The algorithm for the asymptotic solution was devised for the Cauchy problem of the nonpositive spectrum of the limiting matrix. Where degeneracy qualities are considered, however, a periodic solution algorithm is built. Singularly perturbed equations, for example, are utilized in visual inspection quality control, which entails the acquisition of images that have been blurred by some common causes such as wrong focusing, dirty lens and movement of subject. This is especially true when processing images, where concepts and electronic executions are both vital (Morfu and Marquie, 2011).

7.3.4 Boundary Layer Flows (Mebine, 2014)

Boundary layer flows are great topics of interest in physics, fluid mechanics, and engineering processes because of the related viscosity effects on bounding surfaces. Boundary layer flows and heat transfer of viscous fluids over stretching surfaces occur frequently in manufacturing processes such as“metal and polymer extrusions, drawing of copper wires, hot rolling, paper productions, glass-fibre, glass blowing, electronic chips, crystal growing, and metal spinning.”In the investigation, a semi-analytical variational iteration method with Pade approximations was applied to obtain series solutions, which compared favourably well with numerical solutions and those reported in literature about the topic of boundary layer flow with heat transfer.

7.3.5 Structurally Heterogeneous Medium (Olali et al., 2015)

The location of faults such as “cracks, voids, bundles, and external effects” in structural elements has a substantial impact on the reliability of constructions. Therefore, there are developed ways in which structural faults are discovered via non-destructive testing (NDT) followed by an examination of their impact on the strength of the structure.Some effective properties of microwave range of electromagnetic waves or radiation are known for NDTs, which are permittivity, permeability, and conductivity (Vanin,1983). These are relevant to the composite medium in the long-wave approximation. Mathematical modelling offers handy effective methods to gain insights of NDT. From the going, mathematical modelling of structurally heterogeneous medium was explored considering "composite materials in the case of external stresses with the finite length of electromagnetic waves in the presence of essential gradients and frequency characteristics of the field." Our results bring to light the exigencies and peculiarities of the high-frequency field in structurally heterogeneous medium, thereby adding value to the existing literature(Brekhovskiy,1975; Kolodiy, 1985; Ramm, 1969).

7.3.6 Dynamic Photoelasticity (Olali et al., 2015)

This is a method used in solving problems arising in solid mechanics (or fracture mechanics), geophysics, flaw detections and mining that stands out among the methods (Khesin, 1975). The method is distinguished by its versatility and ability to determine the distribution of mechanical stresses and strains from a fringe pattern without the necessity for experimental data processing. What is vital in the use of the technique of dynamic photoelasticity is to know the viscoelastic properties of optically sensitive models of polymers that are isotropic concerning elastic properties (Malezik, 2001).The study of mechanical stresses using an isotropic-photoelastic method for modelling mechanical behaviour is linked to the resolution of the following methodological issues: the selection of a material model that is mechanically similar to natural body materials, the transition to analogous mechanical quantities in nature, and the calculations of stresses and strains in the model. In this research we employed "direct and inverse Laplace transform methods to evaluate the difference in primary stresses and strains in linearly viscoelastic optically sensitive polymer materials based on a time-varying picture of interference fringes." The results depicted a "complete dynamic spectrumin experiments for relaxation at low temperatures."

7.3.7 Integral Boundary Layer Heat Transfer (Mebine, 2016)

External flows surrounding streamlined bodies experience viscous effects, but such effects are restricted close to the body surfaces and wake. Rienstra and Darau (2011) modelled and explained why a thin mean flow boundary layer cannot be ignored due to its physical insights that can aid in the interpretation of experimental results. There are visible natural and industrial applications of external flows in several disciplines as in aerodynamics (planes), hydrodynamics (submarines), transportation (automobiles), wind and ocean engineering such as in water towers and breakwaters, respectively. Heat transfer in these and other engineering processes has become a focus of research. Aside from predicting how heat energy would be transmitted, the study of heat transfer predicts the rate at which it will occur under given conditions. Our tools for the research in this work was the combination of the governing equations of momentum and energy with the inclusion of thermal radiation, which was converted to a nonlinear first-order equation via thermal-to-momentum boundary layer thickness ratio. As simple as that may sound, the equation was solved using singular perturbation method due to its high nonlinearity that presented considerable mathematical difficulty.

Vice-Chancellor, Sir, the results of the investigation which validated those in literature revealed that

- thermal radiation increases diffusivity and reduces viscosity, thereby increasing the boundary layer thickness, and
- thermal radiation increases the heat transfer coefficient significantly.

7.3.8 Convective Fins and the LMM (Mebine &Olali, 2016; Mebine &Porbeni, 2016)

Fins are highly conductive metallic surfaces used to improve heat transfers in heating systems and units in homes, electrical and electronic appliances such as air conditions, automobile radiators, and computer systems; industries such as petrochemical and gas treatment plants, and other applications. In nature, the ears of rabbits act as fins to release heat from the blood. Due to the vast applications of fins, experimental and theoretical studies of fins have dated back several years. Many academics, for example, had focused on fin design optimization and cost-effectiveness to raise or improve the rate of heat transfer.

The temperature distribution mathematical models that come from the energy balance of finned surfaces are nonlinear differential equations of variable or temperature-dependent thermal conductivity and heat transfer coefficients, which are more physically realistic from the viewpoints of natural and scientific processes. The main purpose of the research conducted was the development of effective approximate series solutions via "Leibnitz-Maclaurin Method (LMM) vis-a-viz Successive Differential Coefficients (SDC)" and exact implicit integral solutions. The results obtained are important in gaining insights of heat transfer mechanisms such as conduction, convection, thermal radiation, nucleate boiling, and many more other heat transfer modes that validates existing results.

Vice-Chancellor, Sir, when next you are using your laptop and handset, and they are getting hot it is because of

- thermal conductivity, which raises the surface (wall) temperature. Therefore, the remedy to reduce the rising temperature is to increase the thermo-geometrical parameter, which serves as a cooling agent that suppresses the viscous heating, and
- thermal conductivity and thermo-geometrical characteristics greatly influenced fin efficiency.

Figure 7.4.1 demonstrates pictorial representations - solid lines and field plots (arrows) for dimensionless temperature versus dimensionless coordinate for various heat transfer modes with (a) constant thermal conductivity with variable thermo-geometric fin parameter, and (b) both variable thermal conductivity and thermo-geometric fin parameter for various heat transfer modes.

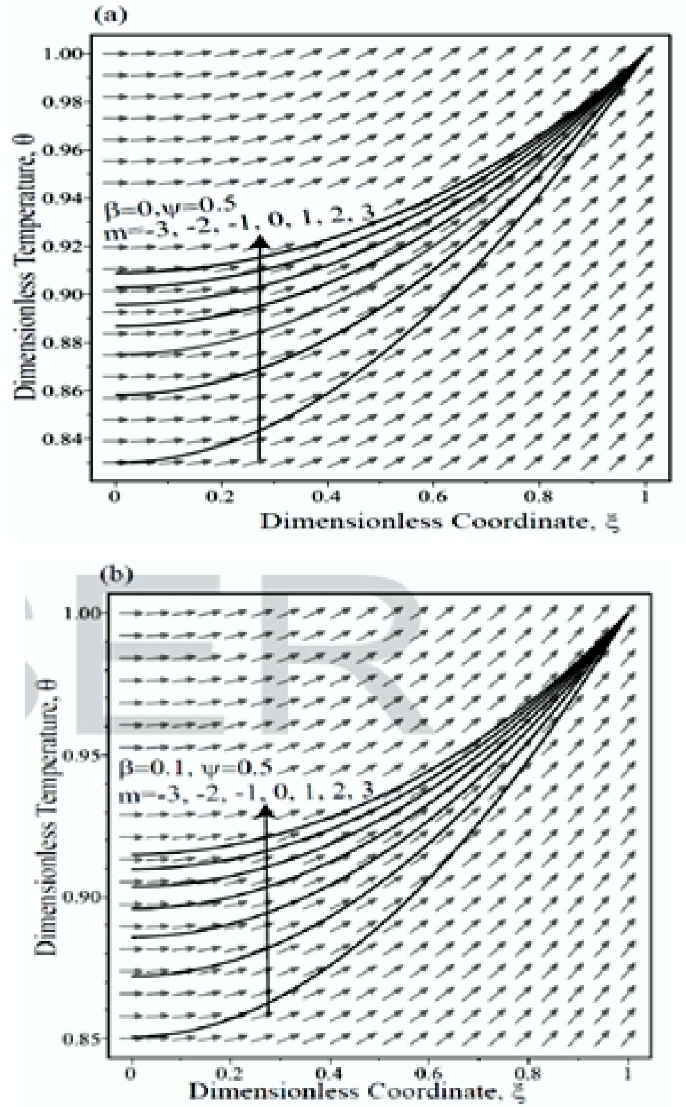


Figure 7.3.1:Dimensionless temperature versus dimensionless coordinate for various heat transfer modes.

7.3.9 Cabelling Phenomenon in Thermal Bar (George & Mebine, 2016)

Cabbelling is a natural occurrence that causes a denser fluid or combination to form at its maximum density temperature. On the other hand, "a thermal bar is a hydrodynamic feature that forms along the margins of holomictic lakes during the seasonal transition to stratified conditions, due to the shorter amount of time it takes for shallow areas of the lake to stratify."

For example, in the spring, surface water near the beaches of a lake warms due to direct solar heating, and this area of the lake warms faster than the deeper half due to its smaller volume and increased radiation absorption by the lakebed. Cabbelling phenomena are mathematically modelled using the hydrodynamic equations and a maximum density temperature of 4^0C. With the help of Multiphysics, George and Mebine (2016) modelled numerical simulations of the Cabbelling phenomenon in thermal bars, and such hydrodynamic processes has many practical applications.

1. On-Going and Further Research Works

The specific research problems considered in my areas of expertise broaden insights about the all-important Applied Mathematics and demonstrate means of extension to providing practical results. Therefore, there is no gainsaying that Mathematics is the bedrock of science and technology for the betterment of our environment. And without science and technology, there would be no development. To this end, there are a considerable amount ofother ongoing research areas that are practically relevant, and many more that require further investigations in the field of Applied Mathematics. A list of some of these are

1. Construction of analytical solutions,secured numerical schemes and computer codes to solve problems of Navier-Stokes hydromagnetic fluid flows with thermal radiation over channels and exponentially stretching sheets. Some prevalent industrial applications of such flows include wire drawing, metal and polymer extrusions, paper productions, manufacturing of plastic and rubber sheets, glass blowing and metal spinning. Some of my Post Graduate Degree Students are exploring the best methods of solving these problems.
2. Development of approximative, perturbative, and asymptotic techniques to solve highly nonlinear differential equations governing physically relevant scenarios. Some of my Post Graduate Degree Students are investigating different methods of approximations using fixed point theory

with considerations of convergence issues.

3. Computation and optimization of mixing and chemical reactions in real river flows (where, when, what, how), with the central focus on discharging with the least amount of environmental impact possible. I have some collaborators in the "Department of Mathematics of Sultan Qaboos University, Oman," who are exploring environmental fluid modelling of effective disposal mechanisms of wastewater and desalination of brine effluents.
4. Effective data fitting models and problems of least-squares for the field, experimental and laboratory studies. Several collaborations have been made and are still going on with researchers in Mechanical and Petroleum/Chemical Engineering and Environmental Noise Pollution Assessments.
5. Model studies of MHD effected biological fluids such as blood flow through stenosed or constricted (indented) arteries.

Conclusion

Mr Vice-Chancellor, Sir, and my enduringly attentive audience, from the discussion you will agree with me that I have established the power and beauty of Mathematics and that it abounds in everything, whether it's in nature or our daily lives, from the mundane issues that are taken for granted to the most sophisticated breath-taking world inventions and discoveries.This buttresses the point that there are lots of uses of Mathematics at the commonplace, as well as many more other sophisticated applications in our environment today that have far-reaching implications for our scientific and technological development. In some quarters, Mathematics is the Language of the New Millennium (Ugbebor, 2000) as it is also known as the Language of the Universe much more than the General Language that initiated the construction of the "Tower of Babel, a story given in Genesis 11:1-9." There is no gainsaying, therefore, the truism of "**Boundless Mathematics: The Novelty of Applications to Life & Panacea to Living**."

My voice is beginning to wane and now seriously begging for water for the past forty-five minutes or so that I have been presenting the very first Inaugural Lecture in Mathematics in the history of the Niger Delta University. The NDU is pronounced in Ijaw as '**ndu**' meaning life, and it is a life that gives support to living. For NDU to continue to give life to Bayelsa State, the academia and Nigeria as a whole, I want to give some life to NDU by way of recommendations.

Recommendations

Mr Vice-Chancellor, Sir, I would like to put on record that almost everything pivots around Mathematics. So, my Inaugural Lecture would be considered incomplete if I do not offer recommendations to the University, Bayelsa State, and the nation. To this end, I would like to make the following recommendations:

Strong Institutional Structure

A University is simply defined as an educational institution of high-level learning and research that awards academic degrees both undergraduate and postgraduate in several academic disciplines. A University could also be described as a marketplace of ideas, where the most superior controls. According to W. E. B. Du Bois, "an American historian and sociologist," that the function of a university is "*not simply to teach bread-winning, to supply teachers for public schools, or to be a centre for polite society; it is above all, to be the organ of that fine adjustment between real life and growing knowledge of life, an adjustment that forms the secret of civilization*."Therefore, I strongly recommend and emphasize that there is a need for a strong institutional structure and culture to be entrenched in the Universities. As for the Niger Delta University, I understand efforts are being made in that direction, and this is to further buttress and give more credence to the efforts made so far.

Change Mathematics Admission Trend

No doubt, Mathematics and related courses are going extinct in our universities. Students rarely opt for Mathematics as their first choice of course. What is prevalent today is that candidates who could not obtain admissions in other courses are moved to study Mathematics as a last resort. These students demonstrate a lack of interest in Mathematics, and indisputably their inability to study the subject as a course in the university. And this is as a result of the overall insight that Mathematics is tough because it is abstract, frightening, and unimaginative; also, the assumption that they would end up as teachers after graduation.

Undoubtedly, even the few students that chose Mathematics as a career eventually resort to rote learning. Everything must, therefore, be done to change this trend. If nothing is done, we would wake up one day to discover that there are no students in the Mathematics Departments, who willingly chose the subject, but were conscripted from other courses where they could not secure admissions into Mathematics which they did not choose in the first instance. This would be absurd! Give incentives to the study of Mathematics to make it attractive and priceable for the admission trend to change.

Mathematics is not Pedantic

As mathematicians, we must do everything within our powers to elicit the interests of students in the subject through our actions and teaching methods. No wonder, Professor Robert Lee Madison once said: "*The true value of a 'lecturer' is determined not by what he knows, nor his ability to impart what he knows, but by his ability to stimulate in others a desire to know.*"

As we all know mathematics is primarily taught as an abstract topic in the traditional "chalk and board" style. Topics are typically presented without a strong emphasis on how they connect to real-world problems, resulting in a pedantic approach to the subject. As a result, there should be a paradigm shift in teaching Mathematics in consonance with current job markets, economic trends, and global competitions to specifically shift the students' mindsets to one of the job producers rather than job seekers. Students will respond positively to Mathematics instruction if they love its realism and applicability in everyday life. This knowledge would allow them to better analyse any given phenomenon.We need to let students understand, visualize, and experience mathematical concepts and applications as lecturers.

There are lots of teaching and learning tools based on Computer Algebra Systems such as *Maple*, *Matlab*, *Mathematica*, *Derive*, *MathCAD*, *Maxima*, *SciLab, MuPAD,* etc*,* which may aid in the attainment of a healthy balance of abilities and knowledge. This makes technical work easier for students, allowing them to focus on principles and applications.On the part of the university administration, frantic efforts must be made to especially fund the teaching and learning of Mathematics in our university by ensuring the employment of the right calibre of staff coupled with the provisions of the appropriate and modern resource materials, textbooks, software and what have you.

Front-Burner Mathematics

We must, as a matter of state and national emergency, put Mathematics at the front burner of intellectual discussion. It is in this way we can frontally bring the challenges confronting education, particularly Mathematics to the notice of the public and receive the necessary funding for the development of the subject and related disciplines. It is quite appalling that some special and endangered areas, for example, Algebra and Number Theory in Mathematics are threatened by extinction in our country. Therefore, I would like to add my voice to the clarion call of adequate budgetary provisions and funding of Education by the Federal Government of Nigeria and the States, particularly at the university level. It must be emphasized here the indisputable global fact that only in the investment of Education that the investor is guaranteed no loss.

Critical Mathematics Education

Education today in the world is increasingly competitive and knowledge driven. There are lots of real-world phenomena and situations that need the brainpower of mathematical and quantitative understanding and prediction on mathematical grounds. However, there is a dearth of those trained in Mathematics in our universities. For the Nigerian nation to be relevant in the league of nations there is the need to engage in serious dialogue that seeks to evaluate and upraise the standing of the scientific and technological enterprise with the Universities and the outside environments.

Mathematics plays a central place in all of these, but critical scrutiny of the list of courses opted for at the Undergraduate level, one discovers that Mathematics is way down the ladder in our Universities. The reason is often that graduates of Mathematics are not well priced in the labour market and their job relevance, prospects and opportunities are ordinarily relegated to the classrooms. Therefore, I hereby advocate that the Federal Government should make conscious policies to ensure or compel Industries, Multinational Companies, and Government agencies to establish functional and well-funded research and development departments or units to be able to utilize the needed expertise in Mathematics and other similar disciplines. I know for sure that our responsible and collective resolve as a nation would make known the essence and realities of Mathematics to our everyday life. This is the way of advanced countries, and Nigeria should follow suit.

Collaborations in Mathematics

The truism of Mathematics cannot be over-emphasized.The economies of the world today are being adjusted, and so many interventionist measures are put in place as a result of the negative impact of the COVID-19 Pandemic. Physical contacts are restricted while more attention is paid to research to find a solution to the pandemic. Scientific meetings, conferences, seminars, and others are now held via Zoom and other means. This is the time when and where scientists, especially

Mathematicians of all specializations are needed to collaborate with other disciplines to search for a lasting solution. The goal of 21st-Century Mathematics is to continue to enhance attempts to bridge division lines within Mathematics, to open more doors to other disciplines, and to promote inter-disciplinary research. Mathematics is found in materials, security issues, demands in software reliability, requirements for automated decision making, future systems such as lighter and autonomous vehicles, smaller satellites, robotics, and automation, and much more (Dubey and Singh, 2014). Mathematics is everything because it is found in everything, and this proves the boundlessness of Mathematics in its applications!

Acknowledgements

Thirukkural once said: "*A timely help rendered, even if small, is far greater in worth than the whole earth*". In an Ivory Tower of this nature, one must have directly or indirectly benefited immensely from the spiritual, intellectual, moral, and financial support of persons, groups, and associations, hence I cannot fail to acknowledge some of those who fit into these categories.

My first appreciation and heartfelt gratitude go to God Almighty, Who by His grace and infinite mercies has brought me to the point I'm today. I'm forever grateful to Him, for it is "…*Not by might, nor by power, but by my Spirit, saith the Lord of hosts*."

I will always be indebted and grateful to my "academic leaders and fathers," who spurred me up to academic excellence. Late Prof. Welford Abbey-Lolo Izonfuo, a very vibrant pioneer Dean of Faculty of Science, initiated my coming to the Niger Delta Universityfrom Rivers State University and Technology (now Rivers State University) via the indefatigable, humane, and award-winning pioneer Vice-Chancellor, Prof. John Buseri. Special thanks are due to late (Hon.) D.S.P. Alamieyeseigha, the pioneer Executive Governor of Bayelsa State, who provided the

funds for the HIPACT Programme in the United Kingdom that accorded me the offer of a PhD Research Fellowship. May the gentle souls of late Prof. W. A-L.Izonfuo and late Chief (Hon.) D.S.P. Alamieyeseigha, Rest in Perfect Peace in the bosom of the Lord. Amen!

I would like to deeply appreciate Professor Emeritus Ronald Smith. I happened to be the last doctoral student of his and completed my PhD Degree in 2006 from Loughborough University, United Kingdom. He was pleased with my mathematical originality and the tireless efforts I directed toward my doctoral studies, but he feared that when I return to Nigeria after my PhD Programme, I will abandon academics and join politics. To the praise and glory of God, those fears were allayed, and today it has gone to the annals of the history of NDU that Ihave presented my Inaugural Lecture to confirm my Professorship.

I must put on record for a special reason, Prof. Kingsley D. Alagoa, who supervised my MSc Degree Research work in Physics (that is, Applied Theoretical Physics) at the time when Postgraduate Programme in Mathematics was not available in Rivers State University, Port Harcourt.I sincerely appreciate him for the fact that his mathematical skills, learned guidance and keen supervision set me on a very good platform for subsequent efforts.

Please, permit me to make a special mention of Prof. E.I. Ohimain, a former Dean of the Faculty of Science, Niger Delta University. I was promoted to the rank of Professor during his tenure as Dean. Also, special thanks are due to my brother and friend, Prof. K. S. Okiongbo, the current Dean of the Faculty of Science, and my colleagues and every other staff of the Department of Mathematics/Computer Science: Dr E. F. Osaisai (HOD), Dr (Mrs) N. Olali, Dr (Mrs) M. A. Orukari, Dr A. B. Okrinya, Dr P. T. Kenekayoro, Dr B. Japheth, Dr A. George, Dr (Mrs) J. I. Consul, Dr B. J. Fawei, Dr A. Goodhead, Dr N. Dienagha, Dr O. Zuonaki.

Let me also especially acknowledge some of my close academic friends and colleagues, who influenced my life directly or indirectly, some of whom in no single order include, Prof. DonbebeWankasi, former DVC (NDU), Prof. J. F. N. Abowei (NDU), Prof. (Mrs) R. H. Gumus (NDU), Prof. E.M. Adigio, VC Maritime University, Dr T. J. Tuaweri, Maritime University; Dr O. Benson (NDU); she was in Loughborough University with me, and she was so fascinated with the name 'quartic equations,' and had always reminded me of those equations anytime and anywhere we meet. Others include Prof. A. A. Osagiede (UNIBEN), Prof. F.B. Sigalo (RSU), Prof. C. Israel-Cookey (RSU), Dr J. Amonieah (RSU), and very many others that time and space may not permit me to mention here. I salute and remember all your supports and encouragement.

I cannot completely give justice to this Inaugural Lecture without making mention of those who started together with me the journey of the study of Mathematics at the Undergraduate, who I tagged the Joyful-Nine-Group-Connections (JEG-C). The study of Mathematics then was fun, very admirable and it was so that when mathematical problems were solved correctly, we were satisfactorily filled as it was where we have eaten real food. That was the passion in studying Mathematics willingly and happily. Today all of us are at one level of academic achievement or the other. I would like to convey my profound thankfulness to God for their lives. In no single order, these are Prof. A. O. Nwaoburu (Professor of Mathematics, RSU), Dr E. Amos (Associate Professor of Mathematics, RSU), Dr P. C. Jackreece (Associate Professor of Mathematics, UNIPORT), Dr L. Isibor (Port Harcourt), Dr I. Godwin (Port Harcourt), Mr D. Igoniderigha (Canada), Chief

(Hon) Sampson Douglas (BYHA) and Mrs D. Abiyesuku (United Kingdom).

Let me at this point gratefully acknowledge my late parents Mr Ekemeghesuodei Thomas and Mrs Febra Mebine, who did not live to see all the achievements God had made happen in my life. To both, my prayer had remained that God continues to grant them Perfect Rest in His bosom. Amen!

My family members have helped me tremendously. I'd want to express my sincere gratitude for their excellent advice, goodwill, and unwavering support. Most especially, I welcome and greet Chief Saturday Mebine - Prake, my eldest brother and representative of our extended family, who also doubled as my father to see that I earn at least a First Degree. I would particularly like to thank Uncle P. Y. Fawei, Chief T. B. Ode -Dabbey, Chief Felix Bipeledei - Ayeribo, Rev. Goodlive Mebine, Rev. Rexford Sam Mebine, Messrs. Ayibakuro Mebine, Ambrose S. Mebine, Robert Mebine, Henry-Sam B. Mebine, Alex Faboh Abbey, Fynemann Bipeledei, Tobin Seibokuro and Werilagebofa Kemeghen, and special appreciations are due to all the youths of Prake, Ayeribo and Dabbey of Foropa Kingdom in Southern Ijaw Local

Government.

Special thanks are due to my one and only darling wife, sister and mother of my home, Mrs Charity Bose Mebine. She is a description of a virtuous woman, my Agwabuma,I applaud your bravery, moral support, and spiritual strength. And to my dear children and grandchild, the Woyins (Woyinpreye, Woyinlayefa, Woyinwomoemi, Woyindouye, Woyinebi and Woyintari that makes the PLEDET Dynasty), I appreciate you so deeply for your great tolerance and understanding.

May I also pay special honour and respect to my in-laws for their resolute trust in my capability to get to the pinnacle of my career! I thank Pa & Mrs Ngozi T. Ezikwa,Baris. Jeff and Mrs Blessing Ezikwa, Mr David & Mrs Joy Enyida, Mr Ibiso& Mrs Hannah Obene. Your prayers, supports and encouragement are highly appreciated. Baris. Jeff Ezikwa, thank you so much for proofreading the Draft of this Inaugural Lecture.

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George and Family, T. J. Ohajunwa and Family, D. Brown-Kosu and Family, Living Gospel Missions Mighty Men of Valour International, Living Gospel Missions Women of Glory International, The Living JoshuasYouth Fellowship of Living Gospel Missions, and many more others. Let God continue to guide and uplift you all in Jesus' name. Amen.

I want to sincerely welcome and appreciate Dr. Gideon C. Osi and his team, for their unreserved support. Since we came to know ourselves, Dr Osi has been a true friend and a brother of other parents. it is my prayer that God Almighty will restore to your strength and resources in double-fold in Jesus name. Amen!

I am, indeed, grateful to the most important and distinguished audience, for paying the debt you owed me by coming and listening to me today. May the good Almighty God honour and reward you in double fold. And ALL said … Amen!!!

And to every one of us, I say a big thank you for being part of this Inaugural Lecture: "**Boundless Mathematics: The Novelty of Applications to Life & Panacea to Living**."Thank you ALL and Journey Mercies.

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45TH INAUGURAL LECTURER

Promise Mebine

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ABOUT THE INAUGURAL LECTURER

Success is a measure of grace and unfettered determination. This is a true reflection in the life and growth of a teenage boy, who grew up in fishing ports, in remote and 'uncivilized' Settlements, short of modern-day standards in all forms and measures in the hinterlands with no dreams of going to school. Interestingly, fate upturned what ordinarily wouldn't have been averted.

Life for this teenage boy, though was not a bed of roses. By no means fit andsheer determination, he weathered the storm and rigours of life to attain the prosperous gifts life could offer. Remarkably, he rose to the pinnacle of his career in the academia to become a 'Professor Per Excellence.’

His innate curious tendencies as a teenage boy informed his constant and deliberate effort to critically observe surface water motions and associated waves in his sojourn of fishing in the waterways of creeks, rivers, and deep seas along Kula,Nembe, Odioama, Brass, Foropa, etc, in Rivers and Bayelsa States. The mystery behind the functionality of these observations, undoubtedly informed his careful selection of study in Mathematical Sciences.

I dare to say, that this teenage boy never allowed his challenged background to deter him of his passion and vision. He chose to rewrite his script, and as well, reshaped his world to a befitting one.It is gladdening to know that the teenage boy is Professor Promise Mebine, the focal point of today's Inaugural Lecture.

Professor Promise Mebine was born on 2nd April, 1967 to the family of Late Mr Ekemeghesuodei Thomas Bebe-abuna Mebine and Late Mrs FebraThomas Mebine (Nee Opou) from Foropaand Ukubie towns, respectively, both inApoi/BassanKoluama District of Southern Ijaw Local Government Area, Bayelsa State.

He attended both St. Matthias Primary School,Foropa, from 1978 - 1980 and State School II, Churchill Road, Port Harcourt from 1981 - 1982. Furthering his education, he attended Community Secondary School, Foropafrom 1983 - 1988, and was appointed a Senior Prefect in 1987. He gained admission into the then Rivers State University of Science and Technology (now Rivers State University (RSU)), Nkpolu-Oroworukwu, Port Harcourt, Rivers State in 1992, to study Pure and Applied Mathematics and graduated in 1997 as the Best Graduating Student in Department of Mathematics/Computer Science and the Best Graduating Student in the Faculty of Science.

He had his mandatory National Youth Service at Ekwe Secondary School, Ekwe in Isu Local Government Area of Imo State from 1997-1998. He went back to the Rivers State University of Science and Technology, Nkpolu-Oroworukwu, Port Harcourt, Rivers State after the National Youth Service, where he was employed as Graduate Assistant in the Department of Mathematics/Computer Science. He immediately enrolled into the Master's Degree Programme of Applied Theoretical Physics in the Department of Physics and completed it in 2001.

Mebine, who had a vision of adding value by empowering and growing his state, started lecturingin Niger Delta University (NDU) from the onset of its establishment whilst yet a staff of RSUshuttling between the two universities. It may interest you to know that he was the only Mathematics Lecturer in the Department of Mathematics in NDU between 2002 and early part of 2003.His quest for knowledge was not assuaged with the First and SecondDegrees, hence, he went further to apply to the Bayelsa State Government for a foreign scholarship to run a PhD programme and was granted. He proceeded to the Loughborough (Lufbra) University in the United Kingdom, where he bagged his PhD in Applied

Mathematics in the year 2006. On his return to Nigeria the same year, Mebine requested his services to be laterally transferred to the NDU, which was not possible in 2002.

With diligence, tenacity of purpose and hardwork, Mebine advanced on the ladder of the academia and was promoted to the rank of Associate Professor (Reader) in2014. In October 2017, our amiable, resourceful, and dynamic son was promoted to the rank of Professor in Applied Mathematics in the State-owned "Niger Delta University, Wilberforce Island, Bayelsa State."Interestingly, Professor Mebine was the:

1. First PhD Holder in Foropa Town,
2. First Professor in Apoi/Bassan/Koluama District in Southern Ijaw LGA,
3. First Indigenous Professor of Mathematics in Bayelsa State.

In addition to these accolades, Mebine is one of the Founding Leaders of KEFFES (KoluamaI, II, Ekeni, Foropa, Fishtown, Ezetu and Sangana) Host Communities to Chevron-Texaco Oil Company Unlimited that has brought lots of benefits to the indigenes and people of those Communities.

He is a veritable resource fellow and guest speaker in Seminars and Conferences both locally and internationally in his field of expertise and endeavour,where he profoundly presented numerous scientific lectures. Mebineas an astute academic has reviewed several scientificjournals and belongs to several Professional Bodies. He has served as an External Examiner to various Universities both at Undergraduate and Postgraduate Levels. He is a productive writer and has written and published numerous Journal Articles of Local and International repute.

Prof. Mebine was awarded ICT Excellence by the Nigerian Computer Society (NCS), in Uyo, Akwa Ibom State in 2010. To complement this achievement, the Rivers State University Alumni Association, Bayelsa State Branch conferred on Mebine a Golden Award in 2020 in recognition of his accomplishment as (i) The First Professor of Mathematics in Bayelsa State of Nigeria, (ii) Outstanding contribution and performance in the advancement of Education in Bayelsa State, and (iii) As a Golden Alumnus of Rivers State University, Bayelsa State Branch.

This affable Professor was appointed as a member of the Bayelsa State Science and Technology Education Board in October 2017. A short while after, “His Excellency, Hon. Henry Seriake Dickson, the then Executive Governor of Bayelsa State” deemed it fit to appoint Professor Mebine as the Pioneer Rector of the only State-owned Bayelsa State Polytechnic,Aleibiri in December2017.

To give further impetus to Mathematics Education in Nigeria, our dedicatedly hardworking Professor was appointed by “Mr President, His Excellency, Muhammadu Buhari GCFR, Commander-In-Chief of the Armed Forces of the Federal Republic of Nigeria,” as “Director/Chief Executive, National Mathematical Centre (NMC), Abuja”in August 2021. Since the establishment of the apex Centre of Mathematical Sciences over thirty-two (32) years ago, the first time a South-South person was appointed as the Director/Chief Executive of the Centre.

Professor Mebine is a Google Scholar with148Citations, an h-index of 6, an i10-index of 3 and a member of Research Gate with 1,493 Reads and 111 Citations as of October 2021.

Professor Mebine is a member of several other Professional Bodies. Some of these include:

- ü Chartered Institute of Record Management (CIRM)
- ü Nigerian Mathematics Society (NMS)
- ü Nigerian Association of Mathematical Physics (NAMP)
- ü Science Association of Nigeria (SAN)
- ü Mathematical Association of Nigeria (MAN)
- ü Nigerian Computer Society (NCS)

His hobbies are Reading, Travelling, Swimming and Cooking.

Prof. Promise Mebineis married to a lovely wife, Mrs Charity Bose Mebine, an Environmental Health Officer at Federal Medical Centre, Yenagoa, and they are blessed with Five Children and a grandchild,the Woyins (Woyinpreye, Woyinlayefa, Woyinwomoemi, Woyindouye, Woyinebi and Woyintari that makes the PLEDET Dynasty).

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