Course Objective

The purpose of this Workshop is to propose a solution to this limitation in Calculus by introducing an entirely new computational algorithm called *specialized differential forms* or (SDF) that would involve the use of Multivariate Polynomials and the differential of Multivariate Polynomials all defined in a very unique algebraic configuration. It will become very apparent throughout the entire Workshop that such a unique algorithm would lead to some form of a *unified theory of analytical integration that* would be driven entirely by *computation*.

This new universal theory in mathematics would be applicable for solving those DEs whose exact solution can only be expressed in terms of the algebraic and elementary functions. We will provide very concrete "*numerical evidence*" of this on a number of very simple mathematical models involving a first order ODE and a second order PDE. This will be followed on the second day of the Workshop with a series of Physical models that have been carefully chosen just for demonstrating the applicability of our *unified theory of integration* into the Physical Sciences. These will include the PDEs used for describing a very specific case of the Navier-Stokes equations corresponding to an incompressible fluid involving heat transfer and variable viscosity. To fundamentally illustrate the complete versatility of our unique algorithm for solving PDEs, we would be describing a general process for attempting to solve the set of PDEs that govern *general linear elastic boundary value problems*.

Course Outline

Day 1:

Mathematical Sciences: *Mathematical foundation of Specialized Differential Forms*

- Introduction to the theory of *specialized differential forms* as a *unified theory of integration* for the representation of all *explicitly* and *implicitly* defined equations consisting of only the algebraic and elementary function in common differential form with applications to solving for *any type* of DEs.
- Detailed computer results obtained as a result of using the method of *Specialized Differential Forms* for solving a very simple first order ODE and a second order PDE.
- Understanding the importance of a *unified theory of integration* for the development of a *unified theory of Physics*.
- The very first block diagram of its kind to suggest that a *theory of everything* could in principle be constructed just from the "*general*" application of our *unified theory of integration* based entirely on the use of *specialized differential forms*.

Computer Science: *Artificial Intelligence*

- Part I of an open discussion on the feasibility for automating the entire computational process involved in applying the method of *specialized differential forms* to solving for any type of DEs including systems of DEs in conjunction with the use of *Artificial Intelligence*.

Day 2:

Mechanical Engineering: *Fluid Dynamics and Mechanics of Material*

- General applications of the method of *specialized differential forms* in Physics and Engineering.
- A very specific case by which our *specialized differential forms* representation of all mathematical equations can be applied to solving for the Navier-Stokes equations involving heat transfer and variable viscosity for an incompressible fluid without requiring the use of any type of conventional transformation processes.
- Moving slowly towards a more universal physical theory of elasticity by solving for the general equations of linear elasticity in terms of *generalized* analytical solutions from the general application of our method of *specialized differential forms*.

Cosmology: *Einstein Field Equations*

- Some preliminary concepts on the exact nature of Einstein Field Equations and how the use of our *specialized differential forms* representation of all mathematical equations can be developed on a more universal scale for attempting to resolve his equations in terms of more *generalized* analytical solutions.
- One very simple case of his equations that was solved by Schwarzschild which led to the discovery of the black hole whose exact analytical solution could be independently arrived at from the general application of our *specialized differential forms*.
- Another case of Einstein Field Equations that has yet to be completely resolved by which our method of *specialized differential forms* expressed in more universal terms could be applied for attempting to establish a more realistic model on the interplay between magnetic and thermal processes in strong neutral stars from the effect of extremely large magnetic fields in the order of 1014G on various types of astrophysical objects.

Computer Science: *Artificial Intelligence*

- Part II of an open discussion on the feasibility for automating the entire computational process involved in applying the method of *specialized differential forms* to solving for any type of DEs including systems of DEs in conjunction with the use of *Artificial Intelligence*.

Who Should Attend

- All those who are seeking for a better alternative to the use of experimental models for the analyses and design of various types of mechanical systems.
- Software engineers and designer of mechanical systems in the Aeronautical and Aerospace industry.
- Professors and graduate students who conduct advanced Scientific and Engineering research on various types of industrial projects.
- Professors and graduate students in Pure and Applied Mathematics always seeking for better and improved methods of "*analytical*" integration that preferably would be driven entirely by computation only.
- Professors and graduate students in Computer Science with a strong background in *Quantum Computers*.
- Physicists and Biologists seeking to improve their method of analysis by becoming less and less dependent on the use of experimental models are also strongly encouraged to attend.

Course Instructor Mike Mikalajunas CIME.

Mike Mikalajunas has a degree in Mechanical Engineering with specialization in Fluid Mechanics and Thermodynamics. He has taken part in a number of research projects with various faculty members from different departments in the same University where he graduated from. This would include a long-term flight simulation project in conjunction with the department of Mechanical Engineering and Canadian Aviation Electronics (CAE). Also included are some software development works related to a program called AUTO, "*Continuation and Bifurcation Problems in Ordinary Differential Equations*" http://indy.cs.concordia.ca/auto/ in conjunction with the department of Computer Science.

Other professional activities going as far back as in the mid 80's included taking part with Dr. Robert Carbone for the launching of a new software consulting company that would provide much greater software accessibility on the PC for large corporations as an alternative to the use of very expensive mainframe computer systems. More information can be obtained by going to http://futurcast.com/ where many of his programs are still being used in large corporations some of which with a total revenue far exceeding $100 Million. They would include *Astra Zeneca, Bayer, Boehringer Ingelheim, Bray Valve & Controls, Bway Aerosol division, Campbell Soup, GlaxoSmithKline (GSK), Glaxo-Egypt, Honeywell, John Crane, Lever Ponds, Merck Frost, Novartis International, Ortho Pharmaceuticals, Roche, Sanofi Aventis, Solvay, Unilever, Upsher-Smith, and Worthington Industries*. Because of his extensive background in C++ and Oracle, Mike Mikalajunas has for many years been assigned to maintaining and supporting the company's own leading Futurcast statistical software package within the giant pharmaceutical company

Boehringer Ingelheim. Under a special license agreement he would be responsible in part for running the entire sales forecasting and assumption reporting software on a monthly basis for the international division of Boehringer Ingelheim that provide services to over 100 countries from around the world in order to meet each of the countries own total manufacturing process requirements.

Mike Mikalajunas was also very extensively involved in the search for some form of a *unified theory of analytical integration* that would be driven entirely by *computation* only. His preliminary results in the form of a universal computational algorithm were made public between 1981 and 1983 to various professional conferences involving three of the largest mathematical societies in the world, (1) "*New algorithm for integrating PDEs"* (SIAM) 1981 Fall Meeting, Cincinnati Ohio (2) *"Representing a PDE in terms of an infinite variety of integrable and non-integrable systems of ODEs"* Abstracts of the American Math Society Vol. 4, Number 5, 87th summer meeting, Albany NY 1983 and (3) *"On the use of Multivariate Polynomials for integrating ODEs"* invited 1 hour address to the Mathematical Association of America (MAA) NY State Mathematical Assoc. of Two Year Colleges, Seaway Section, Spring 1983, Utica NY.

In 2015, the new computational algorithm received general acceptance for presentation at 2 major International Conferences on Computational Methods in Auckland New Zealand (ICCM2015) and at Berkeley University (ICCM2016). This was followed by another one in Melbourne Australia "*13th International Conference on the Mechanical Behavior of Materials, June 2019*".

Also, between 2015 and 2022 many Universities have expressed a great deal of interest for the presentation of his work at one of their regular internal seminars in Engineering and Mathematics. These included from the department of Mechanical Engineering, Carleton *University*, *University* of *California at Davis* and the *University of Memphis*. Also included, the *Purdue School of Engineering & Technology* in Indianapolis, the *School of Engineering Science* at *Simon Fraser University* and finally, the department of Mathematics at *the City University of New York*.

This has also attracted some degree of interest from NASA which as a result of having attended one of their highly advanced Physics Workshop "*NASA Fundamental Physics Workshop April, 2018, La Jolla, CA*", was given the opportunity to make a presentation at their Washington DC headquarters on the use of his own unique computational algorithm for attempting to resolve many of the various cases of the Navier-Stokes equations in more generalized analytical form, *"A method of differential analysis for solving the Navier-Stokes equations in more generalized form"*, NASA Headquarters, June 2018, Washington DC.

During the last SIPS 2022 meeting in Thailand, Mike Mikalajunas presented a total of 3 abstracts from which the first one was presented at the *Horstemeyer International Symposium* and the remaining 2 as a Keynote Speaker at the *5th Intl. Symp. on Sustainable Mathematics Applications*. Each of the presentations were well received which prompted the organizers of the last Symposium to allow him to further expand his ideas into this 2 day Workshop.

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