Topics in Numerical Methods

- **Title**: A Fast Traublike inversion algorithm for LaurentVandermonde matrices
Speaker: *Sirani Perera* (pereras@daytonastate.edu), Daytona State College
Coauthors: *Vadim Olshevsky* (olshevsky@uconn.edu), University of Connecticut; *Tom Bella* (tombella@math.uri.edu), University of Rhode Island

Abstract: It is well-known that Vandermonde matrices may be inverted in only $O(n^2)$ operations by using the Traub algorithm. Later Traub algorithm has been extended from Vandermonde matrices involving monomials to polynomial-Vandermonde matrices involving various classes of polynomials, including real orthogonal polynomials, Szegö polynomials, and quasiseparable polynomials. We extend the case where the "polynomial" system in question is made up to Laurent polynomials; that is, polynomials in both x and x^{-1} . We show that the matrix related to a system of Laurent polynomials as its multiplication operator is in a sense an appropriate generalization of this idea, and we use this relationship to derive a fast algorithm for inversion of Laurent-Vandermonde matrices.

- **Title**: A family of self-starting Extended BDFs with two superfuture points for stiff initial value problems
Speaker: *Robert D. French* (rfrench@my.apsu.edu), Austin Peay State University
Coauthors: *Dr. Samuel N. Jator* (jators@apsu.edu), Austin Peay State University

Abstract: A class of continuous Extended BDFs with two superfuture points are constructed and used to generate a family of extended backward differentiation formulae with two superfuture points. This class of methods is shown to be suitable for the approximate numerical integration of stiff systems of first order ordinary differential equations. An algorithm is described whereby the required solution is predicted using an explicit Adams-Bashforth method of step number $k+2$ and then corrected using an extend backward differentiation formula of step number k with two superfuture points. The method is initialized by solving a block of methods that is provided by the continuous scheme. This approach allows us to develop A-stable schemes of order up to 7, which is an improvement over the EBDF and MEBDF methods of Cash.

- **Title**: Nodal discontinuous Galerkin solutions for shallow water equations on a triangular grid
Speaker: *Vani Cheruvu* (vani.cheruvu@utoledo.edu), The University of Toledo
Coauthors: *Max Gunzburger* (gunzburg@fsu.edu), Florida State University

Abstract: We present a triangle-based nodal discontinuous Galerkin model for the shallow-water equations in two dimensions. The model uses Lagrange polynomials on the triangle and Warburton's interpolation points. We perform a computational study of the convergence rate of the discontinuous Galerkin method in both one and two dimensions for advection and shallow-water equations. The two dimensional models are tested for problems with known analytical solution and the shallow water model is applied to the generation of Kevin and gravity waves. In this talk, I will present details involved in the procedure and conclude with the results. This is my postdoctoral work with Prof. Max Gunzburger at Florida State University.

- **Title**: A Modern Finite Element Method for Computational Fluid- and Magnetohydrodynamics
Speaker: *Jonas T. Holdeman* (j.t.holdeman@charter.net), Knoxville, TN

Abstract: An essential feature of methods for computational fluid dynamics and magnetohydrodynamics is the requirement for vector fields that are divergence-free. A central weakness of the FEM as usually practiced, has been the inability to use bases incorporating the divergence-free condition ab initio, resulting in a multitude of schemes to approximate this condition after the fact. The resolution is quite simple, and it is difficult to understand how it was overlooked for so long. We show strictly-divergence-free bases, which along with a trick mathematicians have used with fluids, lead to the simple FE method to be described. Computed results for a number of applications to CFD and MHD will be shown.