# Current Projects in the Computational Engineering Mathematics (CEM) Group

- The CEM Group continues to make progress in developing new methods for solving computationally difficult transport problems described by partial differential equations. Some of these novel methods include:
  - Using a variety of basis functions including the recent advances made with the digamma function as well as its parent polygamma function.
  - Development of a Nodal Position Algorithm (NPA) to determine optimal placement locations of basis functions that leverage singularities for modeling potential flow characteristics.
  - Expansion of complex variable computational models of potential and transport flow problems into series such as Taylor Series expanded at singularities.
  - Novel applications involving difficult to model flow transport problems that manifest high curvature streamlines among other situations and areas of interest.

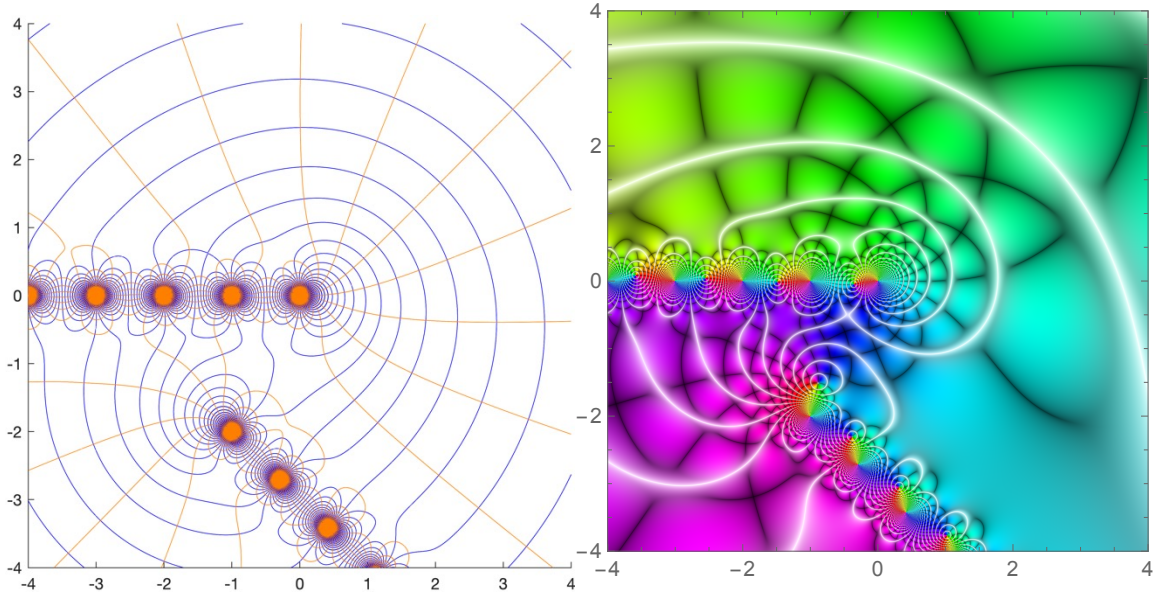

*Figure 1: (Left) Flow net of a linear combination of two digamma functions with various rotations of the digamma axis. (Right) Domain coloring of the linear combination of digamma functions shown on the left.*

The CEM research program currently has several threads of novel conceptual themes that are planned to be continued forward this upcoming summer. Consequently, several opportunities are currently available for cadet research!

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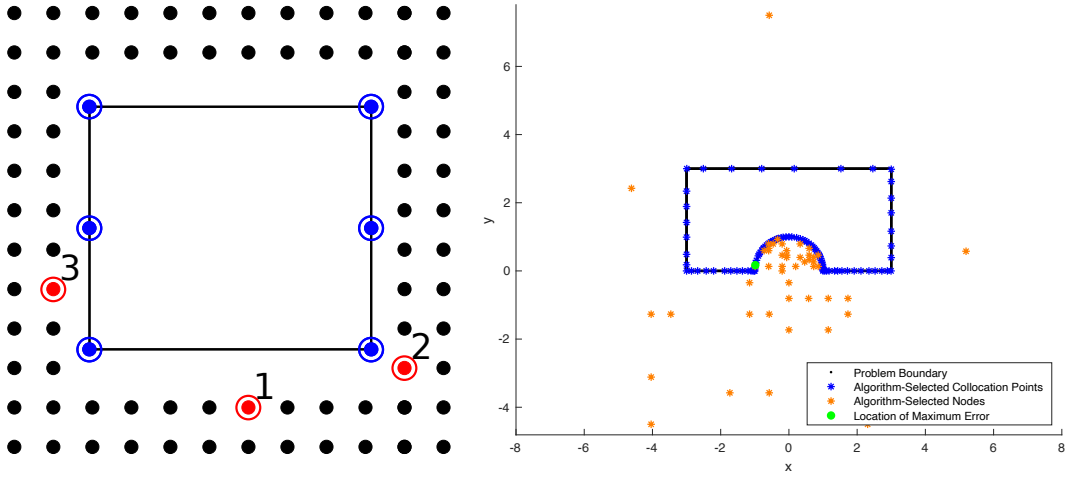


*Figure 2: (Left) Visualization of a single step in the refinement algorithm that is characteristic of nodal position algorithm (NPA) 2. (Right) Depiction of NPA2-selected collocation points in blue and NPA2-selected computational nodes in orange for the problem of modeling potential flow over a cylinder.*

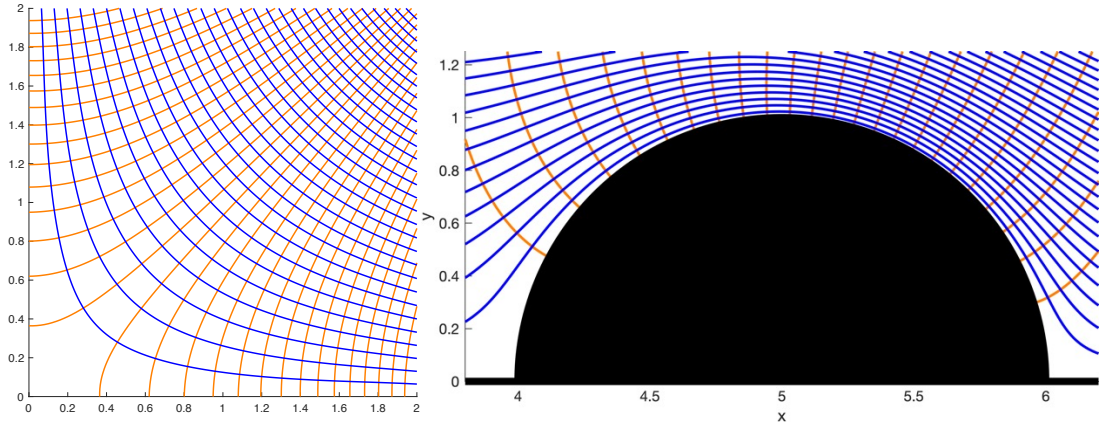


*Figure 3: (Left) Flow net of a CVBEM model using digamma basis functions in an area of extreme curvature approximating potential flow in a 90-degree bend. (Right) Flow net of a CVBEM model around a circular cylindrical obstacle.*

Cadets contribute to these novel research efforts, which have led to several published papers and conference presentations with cadets as authors or co-authors. Additionally, several cadets have been awarded graduate educational fellowships and funding opportunities using this research as part of their application.

The CEM research effort is currently guided by Professor Ted Hromadka of the Mathematical Sciences Department and is supported by a team of specialized individuals with expertise in several relevant areas including visualization, computational methods, programming in several languages, among other talents.