

239c Semi-Analytical Solutions for Elliptic Partial Differential Equations

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Many mass, heat or momentum transfer models can be described by Elliptic Partial Differential Equations (PDEs). As analytical solutions are ruled out for nonlinear boundary conditions, numerical simulations of such Elliptic PDEs for stiff problems require a large number of node points if a good degree of accuracy needs to be achieved. Numerical simulation does not facilitate parametric studies since the parameters need to be established a-priori to the simulation run.

We propose a new semi-analytical solution to solve Elliptic Partial Differential Equations, which results in a symbolic solution as a function of the system parameters and one of the independent variables. The approach involves the numerical discretization of derivatives in one of the space variables (x) and solving the resulting system of boundary value problems analytically in y using matrix methods. The new solution methodology can be used to solve systems that have moving boundaries and non-linear boundary conditions. This methodology has been successfully used to solve current distribution problems in electrochemical systems and for predicting multiple steady states in catalytic monolith reactors.

The working overview, merits and demerits of this approach are highlighted in this poster.

References:

1. V. R. Subramanian and R. E. White, "A Semianalytical Method for Predicting Primary and Secondary Current Density Distributions: Linear and Nonlinear Boundary Conditions," *J. Electrochem. Soc.*, 147 (5), 1636-1644 (2000).
2. V. R. Subramanian and R. E. White, "Semianalytical Method of Lines for Solving Elliptic Partial Differential Equations" *Chem. Eng. Sci.*, 59(4), 781 (2004).