**TEMPLE UNIVERSITY**
Department of Mathematics

# Applied Mathematics and Scientific Computing Seminar

Room 617 Wachman Hall

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## High-order Methods for a Pressure Poisson Equation Reformulation of the Incompressible Navier-Stokes Equations

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**Abstract.**

Popular schemes for the incompressible Navier-Stokes equations (NSE), such as projection methods, are efficient but may introduce numerical boundary layers or have limited temporal accuracy due to their fractional step nature. Pressure Poisson equation (PPE) reformulations represent a class of methods that replace the incompressibility constraint by a Poisson equation for the pressure, with a suitable choice of the boundary condition so that the incompressibility is maintained. PPE reformulations of the NSE have important advantages: the pressure is no longer implicitly coupled to the velocity, thus can be directly recovered by solving a Poisson equation, and no numerical boundary layers are generated. In this talk we focus on numerical approaches of the Shirokoff-Rosales PPE reformulation. Interestingly, the "electric" boundary conditions provided for the velocity render classical nodal finite elements non-convergent. We thus present two alternative methodologies, mixed finite element methods and meshfree finite differences, and demonstrate that these approaches allow for arbitrary order of accuracy both in space and in time.