**TEMPLE UNIVERSITY**
Department of Mathematics

# Applied Mathematics and Scientific Computing Seminar

Room 617 Wachman Hall

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## Numerical behavior of saddle point solvers

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**Abstract.** Symmetric indefinite saddle–point problems arise in many application areas such as computational fluid dynamics, electromagnetism, optimization and nonlinear programming. Particular attention has been paid to their iterative solution. In this contribution we discuss several theoretical questions and practical aspects related to the application of preconditioned Krylov subspace methods. For large–scale saddle point problems, the application of exact iterative schemes and preconditioners may be computationally expensive. In practical situations, only approximations to the inverses of the diagonal block or the related cross-product matrices are considered, giving rise to inexact versions of various solvers. Therefore, the approximation effects must be carefully studied. Two main representatives of the segregated solution approach are analyzed: the Schur complement reduction method, based on an (iterative) elimination of primary variables and the null-space projection method which relies on a basis for the null-space for the constraints. In particular, for several mathematically equivalent implementations we study the influence of inexact solving of inner systems and estimate their maximum attainable accuracies. We can show that some implementations lead ultimately to residuals on the level of the roundoff, independently of the fact that the inner systems were solved inexactly with a much lower accuracy. Indeed, our results confirm that the generic and cheapest implementations deliver approximate solutions which satisfy either the second or the first block equation to working accuracy. We give a theoretical explanation for some behavior which has been observed and is tacitly known. The implementations that we point out as optimal are seen to be those which are widely used and often suggested in applications.