
Roland W. Freund
**A Flexible Conjugate Gradient Method and its
Application in Power Grid Analysis of VLSI Circuits**

Department of Mathematics
University of California
Davis
One Shields Avenue
Davis
CA 95616
`freund@math.ucdavis.edu`

The design and verification of today's very large-scale integrated (VLSI) circuits involve some extremely challenging numerical problems. One of the truly large-scale problems in this area is power grid analysis. Power grids are modeled as networks with up to 10 millions nodes. Steady-state analysis of power grids requires the solution of correspondingly large sparse symmetric positive definite linear systems. The coefficient matrices of these systems have the structure of weighted Laplacians on three-dimensional grids, but with 'boundary' conditions given on a subset of the interior grid points. Strongly-varying weights and the interior boundary conditions have the effect that solutions of these linear systems are often very localized, with components of the solution being near zero in large parts of the grid. In this talk, we present a flexible conjugate gradient method that is tailored to the solution of the truly large-scale linear systems arising in VLSI power grid analysis. The algorithm allows changing preconditioners and sparsification of the search directions at each iteration. These are the key features to exploit the local nature of the solutions. We also discuss the problem of constructing efficient preconditioners for the linear systems in VLSI power grid analysis, and we present results of numerical experiments.