30. Obtain solutions using the program duct ($b/a = 1$) for a 21^2, 41^2, 81^2, 161^2, and 321^2 grid both for the finite element and the finite difference method.

a) For each grid determine through iteration the optimum value of the iteration (SOR) parameter λ_{opt}, and the corresponding number of iterations N_{iter}. Help: You need to determine to evaluate λ_{opt} to an accuracy of $\sim 10^{-3}$ (or better for higher grid numbers) and examine if you can use the value of $2-\lambda_{opt}$ as a predictor for the next higher grid number.

b) Plot $\ln N_{iter}$ versus $\ln N$ (with $N = N_x \cdot N_y$) for the fde and fem methods. What asymptotic ($N \to \infty$) scaling do you obtain for N_{iter} for the respective discretization?

c) Plot $\ln(2-\lambda_{opt})$ versus $\ln N$for the fde and fem methods. What asymptotic ($N \to \infty$) scaling do you obtain for the value of $2-\lambda_{opt}$.

31. Use the same grid sequence (as in problem 30) for the program duct with finite differences and determine the number of iterations for Jacobi and Gauss-Seidel (GS) iterations. Plot the number of iterations $\ln N_{iter}$ versus the number of grid points ($\ln N$). What scaling do you obtain now for N_{iter} and $N \to \infty$ and how does the numerical effort for the two methods compare to the SOR method in problem 30 (How do $N_{iter,GS}/N_{iter,SOR}$ and $N_{iter,J}/N_{iter,SOR}$ scale with the total number of grid points)?

32. Report on the progress of your work on the project.

Please turn in the solutions to the homework on Monday, 4/8/2013