Nonlinear Eigenvalue Problems: Analysis and Numerical Solution

Volker Mehrmann

Institute of Mathematics
Technische Universität Berlin, Germany

Lecture 1. Matrix polynomials in science and engineering

In this lecture we discuss several applications of matrix polynomials in vibrational problems from science and engineering. We develop the concepts for the relevant structures that arise, which range from even/odd via palindromic to self-adjoint matrix polynomials.

Lecture 2. Theory of structured matrix polynomials

We discuss the canonical forms (Smith forms) for general and structured matrix polynomials. We recall and extend the classical theory of linearization of matrix polynomials and show that for the preservation of structure new concepts of linearization spaces are necessary.

Lecture 3. Numerical methods for small nonlinear eigenvalue problems

Classical methods for nonlinear eigenvalue problem are discussed and compared. It is shown that many of these have deficiencies, in particular in the case of singular matrix polynomials and those many invite eigenvalues. This leads to new deflation techniques based on structured equivalences. We will present these methods and discuss there performance including the perturbation analysis.

Lecture 4. Numerical methods for large scale linear and nonlinear eigenvalue problems

Returning to the problems from industrial practice, many challenges arise. We discuss the deficiencies of current methods and indicate new directions or research, in particular towards adaptive methods and homotopy methods.