Asymptotical behavior of DAEs in circuit simulation

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The asymptotical behaviour of differential-algebraic equations (DAEs) is well-studied for special classes of index 1 only. Recent investigations have shown that the numerical solution of higher index DAEs with standard integration methods can behave completely different as expected from the ODE point of view (see e.g. [3]).
The mathematical models for numerical simulation of integrated circuits lead to strongly nonlinear DAEs of the form

$$A(x)\dot{x} + f(x) = s(t),$$

which can be of higher index (see e.g. [1], [2], [4]). We want to present our investigations about asymptotical behavior of solutions of such DAEs. Furthermore we will present a set of rules for the development of proper models that guarantee asymptotical stability for stationary solutions of homogeneous systems

$$A(x)\dot{x} + f(x) = 0$$

if the eigenvalues of the matrix pencil $\{A(x), f'_x(x)\}$ have negative real parts (as we expect it from the theory of ODEs).

Literatur

[1] Günther, M., Feldmann, U.: CAD based electric circuit modeling in industry. Part I: Mathematical structure and index of network equations. To appear in Surv. Math. Ind.

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