Numerical well formulated index-1 and index-2 DAEs

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The asymptotic behaviour of solutions of DAEs is determined by the flow restricted to certain constraints. Integration methods like the BDF method and the Runge-Kutta methods may produce numerical solutions with an entirely other asymptotic behaviour as expected from the ODE point of view. If the constraints and the corresponding subspaces vary with respect to time then integration methods have problems to reproduce these variations correctly.
A correct reproduction is ensured when the discretization and the decoupling procedure commute. It comes out that this happens if the relevant part of the inherent regular ODE has a constant state space and, for index-2 DAEs, a certain subspace (describing the hidden constraints) is constant. Different kinds of reformulation are studied to obtain numerically well formulated systems. Such a reformulation might be expensive. Criteria ensuring the given DAE to be numerically equivalent to a numerically well formulated representation are proved. In this way, an expensive reformulation can be avoided.