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Multistep methods for initial value problems in implicit differential- algebraic equations.

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This paper considers the applicability of general multistep methods (rather than the customary BDF methods) in the solution of implicitly coupled differential and algebraic equations given by

$$(1)\quad \begin{cases} f((C(t)x(t))', x(t), t) = 0, & t \in [t_0, T] \\ C_0(x(t_0) - a) = 0, & a \in \mathbb{R}^m. \end{cases}$$

Conditions are derived for the uniqueness of a solution to (1) and a selfstarting variable k-step method is introduced which includes the Euler, one-leg, BDF and linear multistep method as special cases. The order of this general family of methods when applied to (1) is examined and it is noted that these methods do not in general have the same order when applied to explicit differential equations.

The stability of this family of methods when applied to (1) is defined and sufficient conditions are derived for the stability of one-leg, BDF and linear multistep methods (when $A(t) = E$) when applied to linear problems of the form

$$(2)\quad \begin{cases} A(t)(C(t)x(t))' - B(t)x(t) = h(t), \ t \in [t_0, T] \\ A(t_0)C(t_0)(x(t_0) - a) = 0. \end{cases}$$

Hence it is shown that one-leg and BDF methods can be applied to the general problem given by (1) but that it is only useful to apply the general linear multistep methods to (2) with $A(t) = E$. The paper concludes with some convergence results.

Reviewer: K.Burrage

MSC:

65L05	Numerical methods for initial value problems involving ordinary differential equations	Cited in **3** Documents
65L20	Stability and convergence of numerical methods for ordinary differential equations	

Keywords:

multistep methods; implicitly coupled differential and algebraic equations; variable k-step method; Euler; one-leg; BDF; order; convergence

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