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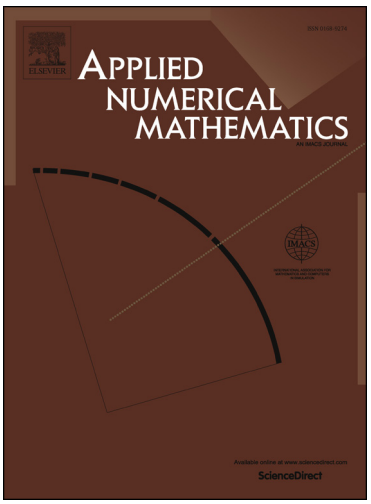

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Index-analysis for a method of lines discretising multirate partial differential algebraic equations

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Abstract

In radio frequency applications, electric circuits generate signals, which are amplitude modulated and/or frequency modulated. A mathematical modelling typically yields systems of differential algebraic equations (DAEs). A multivariate signal model transforms the DAEs into multirate partial differential algebraic equations (MPDAEs). In the case of frequency modulation, an additional condition is required to identify an appropriate solution. We consider a necessary condition for an optimal solution and a phase condition. A method of lines, which discretises the MPDAEs as well as the additional condition, generates a larger system of DAEs. We analyse the differential index of this approximate DAE system, where the original DAEs are assumed to be semi-explicit systems. The index depends on the inclusion of either differential variables or algebraic variables in the additional condition. We present results of numerical simulations for an illustrative example, where the index is also verified by a numerical method.

Keywords: differential algebraic equation, differentiation index, consistent initial value, multirate partial differential algebraic equation, method of lines, optimization.

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