On the numerical solutions of linear delay differential-algebraic equations

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Differential-algebraic equations (DAEs) have an important role in modeling practical systems, wherever the system needs to satisfy some algebraic constraints due to conservation laws or surface conditions. On the other hand, time-delays occur naturally in various dynamical systems, both physically, when the transfer phenomena (energy, signal, material) is not instantaneous, and artificially, when a time-delay is used in the controller. The combination of differential-algebraic equations and time-delays leads to a new mathematical object: "delay differential-algebraic equations (Delay-DAEs)", which is a source of many complex behavior.
In this talk, we address the computational problem for numerical solutions to general linear Delay-DAEs. First, we discuss the characteristic properties, which have not been mentioned in prior studies of numerical solutions to Delay-DAEs. Then, we propose an algorithm, which extends the classical (Bellman) method of steps, to determine the solution of general linear Delay-DAEs. The properties of the algorithm are studied and the theoretical results are illustrated with numerical examples.