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Existence of accurate methods for nonlinear ordinary differential equation numerical solution

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Herein a discrete variable method for solving Cauchy problem

$$dx/dt = f(t,x),\ x(t_0) = x_0\ , (1)$$

where $t,\ t_0 \in R^1,\ x,\ x_0 \in R^n,\ f(t,x) \in R^n$, furnishes a vector x_k to each lattice point t_k as an approximation to value $x(t_k)$ of the problem (1) exact solution at the point t_k , $k = 1,2,...$ The applied method is exact (accurate) in the sense that $x_k = x(t_k)$, $k = 0,1,2,...$, and it will be called the discrete variable exact (accurate) method. Following theorem results the paper [1].

Theorem. If in the system (1)

$$f(t,x) = A(t,x)x$$

and if the nЧn-matrix A(t,x) every element is a real constant or a function which is $n-1$ times continuously differentiable with respect to t, x and furthermore which is a first integral of the equations system (1) then for any initial values $t_0 \in R^1,\ x_0 \in R^n$ and for any positive step h exists a positive integer s less than n and there are existing as the explicit one-step one-level using the first s derivatives of x by t exact methods so the explicit (s + 1)-step linear exact methods for an accurate numerical solution of the initial value problem (1) by the step h.

References:

[1] Gurjanov A.E., Linear stationary ordinary differential equations systems numerical solution exact methods, Leningrad University Herald (Vestnik Leningradskogo Universiteta), Leningrad, Series 1, Issue 2 (N 8), 1988, pp. 17–21. (In Russian).