

Numerik steifer Probleme

Aufgabenblatt 2

Aufgabe 1

Derive the coefficients for BDF-2 for a variable time step size. Determine the order of consistency for a fixed Δt . (4 P)

Aufgabe 2

Consider the methods

$$y_{n+1} + 4y_n - 5y_{n-1} = \Delta t(4f_n + 2f_{n-1}), \quad (1)$$

$$y_{n+1} - y_n = \Delta t(3/2f_n - 1/2f_{n-1}). \quad (2)$$

The second one is Adams-Bashforth-2.

- Determine the order of the methods.
- Use the two methods to solve (for example using a MATLAB code of yours), the equation $\dot{y} = y$, $y(0) = 1$ until $t = 0.4$ with $\Delta t = 1/10, 1/20, 1/40, 1/80$. Plot the error. What happens?

(4 P)

Aufgabe 3

Use the MATLAB solvers `ode45` and `ode23s` to solve the initial value problem (IVP)

$$\begin{aligned} \dot{c}_A(t) &= -0.04 c_A(t) + 10^4 c_B(t) c_C(t), \\ \dot{c}_B(t) &= 0.04 c_A(t) - 10^4 c_B(t) c_C(t) - 3 \cdot 10^7 c_B^2(t), \\ \dot{c}_C(t) &= 3 \cdot 10^7 c_B^2(t), \\ c_A(0) &= 1, \quad c_B(0) = c_C(0) = 0, \end{aligned}$$

for the time interval $t \in [0, 100]$. Plot the solution for each of the solvers. What happened? How many time steps did the solvers need? (4 P)

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