

Re: How to solve a stiff ODE system?

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- *From:* "Narasimham" <mathma18@xxxxxxxxxxxx>
 - *Date:* 3 Dec 2006 12:56:49 -0800
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Orlando wrote:

Narasimham wrote:

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$$\frac{dY}{dt} = f(t, Y), Y(t_0) = Y_0$$

Warning: Failure at t=1.533227e-003. Unable to meet integration tolerances without reducing the step size below the smallest value allowed (5.447117e-018) at time t.

Suspect stiffness is not a problem, cannot say further as you do not indicate $f(t, Y)$. For $\epsilon = 10^{-8}$, if initial condition $Y(t_\epsilon) = Y_0$ is used and ode behaves well, then problem was with usage of first order equation. To fix such cases switch over to a second order differential equation providing two initial conditions.

Thank you very much for your answer!

The ode system of mine is as follows:

$$\begin{aligned} dy(1) / dt &= y(2) \\ dy(2) / dt &= - (y(3) - y(4)) / \epsilon_0 / E^2 \\ dy(3) / dt &= 1 / \epsilon_0 / y(2) / E^2 * (y(3)^2 - y(3) * y(4) * (1 - \epsilon_0 * R_i / \mu_+ / e)) \\ dy(4) / dt &= 1 / \epsilon_0 / y(2) / E^2 * (y(3) * y(4) * (1 - \epsilon_0 * R_i / \mu_- / e) - y(4)^2) \end{aligned}$$

Where,
 ϵ_0 : permittivity of vacuum $8.85e-12$
 $E = E(t)$: the electric field. it is a function of t. After integrating one step of the ODE, the electric field should be recalculated from $y(1), y(2), y(3), y(4)$, and this formula doesn't belong to the ODE

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system, so it is not given here.

Ri: the recombination coefficient of bipolar charge. $2.2e-12$

mu_+, mu_-: the mobility of positive and negative charge, $1.6e-4$

e: elementary charge $1.6e-19$

The above system is used to model the space charge flow of the high voltage direct current power line.

I still don't quite follow you: how should I switch to a second order differential equation? What is the reason of doing this? And how to apply this procedure to my ODE system?

Thank you again!!

Before going to second order, at first redefine terms so that you compute quantities in absolute value range (.01–10). Tried to solve the ODE numerically. It crashes at start of any chosen time interval, even as an initial value problem, found no errors. Perhaps you need to at first check the physics modeling even as an IVP. In a simulation program start with the simplest electrostatic situations of equipotentials or force lines and equations depicting them. When it works, gradually increase its complexity in steps. That traps the error at a particular stage.

Narasimham

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