MA 427 Project # 4 Due: December 8, 2003

- Project description:
  - ◇ Solve the following three differential systems with the indicated specifications.
    1. Equation (van der Pol equation):

$$\begin{aligned} \frac{dy_1}{dt} &= y_2, \\ \frac{dy_2}{dt} &= \mu * (1 - y_1^2) * y_2 - y_1, \end{aligned}$$

Initial value: $y(0) = [2; 0]$,
Interval of integration: $tspan = [0, 20]$.
Tolerance: $tol = 10^{-7}$.
Parameter: $\mu = 1$ and $\mu = 500$.

    2. Equation (Lorentz's strange attractor)

$$\begin{aligned} \frac{dy_1}{dt} &= a(y_2 - y_1), \\ \frac{dy_2}{dt} &= cy_1 - y_2 - y_1 y_3, \\ \frac{dy_3}{dt} &= y_1 y_2 - by_3. \end{aligned}$$

Initial value: $y(0) = [1, 1, 1]$.
Interval of integration: $tspan = [0, 40]$.
Tolerance: $tol = 10^{-10}$.
Parameter: $a = 10$, $b = 8/3$, and $c = 30$.

    3. Equation (Belousov oscillating chemical system):

$$\begin{aligned} \frac{dy_1}{dt} &= 77.27 * (y_2 - y_1 * y_2 + y_1 - 8.375 * 10^{-6} * y_1^2), \\ \frac{dy_2}{dt} &= (-y_2 - y_1 * y_2 + y_3)/77.27, \\ \frac{dy_3}{dt} &= 0.161 * (y_1 - y_3). \end{aligned}$$

Initial value: $y(0) = [4; 1.1; 4]$,
Interval of integration: $tspan = [0, 350]$.
Tolerance: $tol = 10^{-3}$.

4. Equation (Houwen nuclear reactor 2-variable model):

$$\begin{aligned} \frac{dy_1}{dt} &= 0.2 * (y_2 - y_1) \\ \frac{dy_2}{dt} &= 10 * y_1 - (60 - 0.125 * t) * y_2 + 0.125 * t \end{aligned}$$

Initial value: $y(0) = [0; 0]$,
Interval of integration: $tspan = [0, 400]$.
Tolerance: $tol = 10^{-7}$.

- ◇ Use the differential equation solvers **ode45**, **ode113**, **ode15s** and **ode23s** to solve the problems.
- ◇ Compare the performance of these solvers on your problems. The comparison should include the CPU time used in each case. I shall explain these in class.
- ◇ You do not need to explain where the differential equations come from. Neither do you need to make any theoretical prediction or conjecture. You should make critical comments on the performance evaluation, instead. Be aware that some of the cases will take a long time to integrate.

- Due date:
  - ◇ No later than 4:00 pm on Monday, December 8, 2001 at my office.
  - ◇ All results, graphs, and tables need to by typeset.
  - ◇ Hand-written report or drawings will *not* be graded.
- Extra remarks:
  - ◇ Please note that a differentiation will be made between a hard work and a medicore work. You won't have good grades simply because you did the projects. You must prove that you deserve an A. Try to make your project stand out among the crowd.