In the name of God

Department of Physics
Shahid Beheshti University

COMPUTATIONAL PHYSICS

Exercise Set 5

(Date Due: 1394/09/25)

1. For cooling differential equation, calculate analytical solution as well as numerical one. Then plot Δ as a function of discretization parameter.

2. Compute Temperature profile for position and time for a rod.

3. Solve Laplace's equation numerically. (relaxation method or finite difference method)

4. Solve the following integration numerically:

$$\langle v_z^2 \rangle = \int_{-\infty}^{+\infty} dv_x \int_{-\infty}^{+\infty} dv_y \int_{-\infty}^{+\infty} dv_z v_z^2 p_v(\vec{v})$$

here $p_v(\vec{v}) = \left(\frac{\beta m}{2\pi}\right)^{3/2} \exp\left(-\frac{\beta m \vec{v}^2}{2}\right)$. You can imagine any values for free parameters.

5. Write down a program to compute the rounding errors of your computer for single and double precisions.

6. Using Euler and RF4 methods, solve following initial value problem:

$$y''(t) + ay'(t) + \omega^2 y(t) = \cos(\omega_1 t)$$

with $y(0) = A$, $y'(0) = 0$ and take any arbitrary values for other free parameters.

7. Linear Boundary value problem: Suppose numerically $y''(t) + 2y'(t) + y(t) = 0$ with $y(0) = 1$ and $y(1) = 3$ and compare it with exact solution.
(For more details see:
http://www.stewartcalculus.com/data/CALCULUS%20Concepts%20and%20Contexts/upfiles/3c3-2ndOrderLinearEqns_Stu.pdf).

8. Non-linear Boundary value problem: Solve numerically following equations:
A: $y''(t) = 2y(t)^3 - 6y(t) - 2t^3$ with $y(1) = 2$ and $y(2) = 5/2$. (The exact result is $y(t) = t + 1/t$).
B: $y^{(3)}(t) + y(t)y''(t) - y'(t)^2 + 1 = 0$, with $y(0) = 0, y'(0) = 0, y(1) = 0$.
C:$y^{(4)}(t) + y(t)^2 = \frac{t^{-5/2}}{16}(9 + 30t + 105t^2) + t^3(1-t)^4$, with $y(0) = 0, y'(0) = 0, y(1) = 0, y'(1) = 0,$. (The exact solution is $y(t) = t^{3/2}(1-t)^2$).

Good luck, Movahed