In the name of God

Department of Physics
Shahid Beheshti University

ADVANCED COURSE ON COMPUTATIONAL PHYSICS AND OPTIMIZATION

Exercise Set 4

(Due Date: 1403/02/05)

1. Discretization: Use the "*dataprofile.txt*" and compute the derivative of signal with 3-point, 5-point, 7-point and 9-point neighbors in central difference formula (CDF). Compare your results. **Hint:** in the class I taught 3-point and 5-point central difference formula.

2. Implicit and Explicit methods for solving differential equation:
A: Suppose that $f' \equiv \frac{df(x)}{dx} = f^2(x)$ and step size $\Delta x = 0.5$ and $f(x = 1) = 1$. Use explicit and implicit approaches to compute $f(x)$. Compare your results.
B: Suppose that $f' \equiv \frac{df(x)}{dx} = -f(x)$ and step size $\Delta x = 0.5$ and $f(x = 1) = 1$. Use explicit and implicit approaches to compute $f(x)$. Compare your results.

3. 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.

4. Using iterative relaxation method try to solve equation mention in above question. Compare your results.

5. For previous equation, use finite difference method to solve y as a function of t. Suppose the $t_{initial} = 0$ and $t_{final} = 10$ with $N = 1000$. Compare your result with results given in two previous questions.

6. Solve Laplace's equation ($\nabla^2\Phi(x, y) = 0$) numerically for a 2D area with 300×300 pixels. Suppose that $\Phi(0, y) = y^2$, $\Phi(x, 0) = x$, $\Phi(L, y) = 0$ and $\Phi(x, L) = 1$ (relaxation method or finite difference method)

Good luck, Movahed