PHYS580 Lab 01 - Aug 22, 2019

Assignment: First do the get-acquainted activities in (1) as a hands-on exercise together with your TA. Then, perform the remainder of the activities (2) through (5) on your own, and hand in a detailed report at the beginning of the Lab 2 next week (Aug 29). You need not to include the activities in (1) in your report (because those will not be graded).

Lab 1 Activities:

1. Hands-on introduction to basic tasks using computers and Matlab:
   a) Log in to your ITaP account, then create a folder dedicated to PHYS580 and a sub-folder for Lab 1 within it.
   b) Start Matlab (or the language/software of your choice), designating how and where your programs will reside and be called.
   c) Learn to do simple plots of a single-variable function, such as $f(x) = e^{-x/3} \sin(5x)$.
   d) Learn how to read input from keyboard or text files and to plot/print output. For example, create a text file containing 10 numbers (one in each line). Write a program that reads the numbers, computes their sum, and outputs it.
   e) Say, we have a function $f(x,y,t) = \sin(2\pi x) \sin(2\pi y) \cos(2\pi t)$ for x,y in the range of [0,1]. Learn to visualize the function as a movie as you vary t.
   f) Go to the course home page at www.physics.purdue.edu/phys580 and download the starter Matlab program for Lab 1 to your Lab 1 area of the ITaP file space. Make copies before editing it to work on the rest of the assignment. (Or use the starter program as a guidance for writing corresponding programs in your chosen language.)

2. Implement the Euler approximation for the nuclear decay problem of Ch 1, in Matlab (or any language of your choice, provided you are familiar with it and do not wish to make use of the provided starter codes). Compute solutions from $t = 0$ to 5τ using time steps $\Delta t/\tau = 0.05, 0.2, 0.8, 1$, and 1.5. Plot the Euler approximation results together with the exact solution.

3. Calculate and analyze the deviations between your Euler results in (2) and the exact result, and study their dependence on the step size $\Delta t/\tau$ (at fixed t) **and** on t (number n of steps used up to t) at fixed $\Delta t/\tau$, in the range $t = 0$ through 5τ. Include a plot of the cumulative deviations (i.e., the *global* error) as a function of t, both in absolute terms and also as a fraction relative to the exact values.

4. Implement the second- and fourth-order Runge-Kutta approximations, and do the same as in (2) and (3). How do the Runge-Kutta results compare to the exact solution and to the Euler approximation results? Perform an analogous error analysis to what you did in (3).

5. Based on your findings above, can you make any general observation regarding the approximation methods used here?