Bacteria Growth in a Lab Experiment

Homework 6
Due 8 March 2023

A. Reading assignment: Read sections 4.6.1 and 4.6.2 in the class textbook.

B. A biological laboratory experiment involves the analysis of a strain of bacteria in a colony. The number of bacteria $p(t)$ in this colony at time t (in hours) is given by

$$\frac{dp(t)}{dt} = p_0\, \mathrm{e}^{\sqrt{\beta t}-\alpha t}\,(1+\alpha t)^2 \left(3\alpha + (1+\alpha t)^{1.002}\left(\frac{\beta}{2\sqrt{\beta t}} - \alpha\right)\right), \tag{1}$$

where $\alpha = 2.5$/hour, $\beta = 3.75$/hour, and $p_0 \equiv p(t = 0.001 \text{ hours})$ is the initial number of bacteria in the colony.

Task

Write a structured Fortran program which uses the Euler forward differentiation method to determine the number of bacteria in the colony for times $0 \leq t \leq 6$ hours.

Program Design

- The program must contain a preamble and must be well commented.
- The initial population, p_0, and the final time, $T = 6$ hours, are keyboard input. The code must prompt the user to input these values from keyboard.
- Use the `OPEN` statement to write the number of bacteria for times $0 \leq t \leq T$ hours to an output file.
- To solve the differential equation, use a temporal step size of $\Delta t = 0.001$ hours.
- Run the program for initial populations of $p_0 = 100$, 250, and 500 and show the results graphically in python plot. Make sure the curves and axes are properly labeled.

Submitting your Homework: Create a gzipped archive file named `LastFirst_HW6.tgz` that contains your fortran source code and (`pdf`) python plot and email this file to `ewhart317@gmail.com`. Put `LastFirst PHYS 317 HW 6` in the subject line.