PHZ4151C, Fall 2019
Homework 6
Due Friday Nov 15th, 11.59PM

Instructions: Solve all five problems. Every problem is worth 10 points. Write your codes following the strategy discussed in the "Structure of the program and program design" video and the format used in the sample programs discussed in the class and lecture videos. Make sure that your code is clear, readable for users other than yourself, and properly commented. Once finished, include all your program files and figures into a zip file named after your last name and homework number (e.g. "Ullah_HW6.zip") and submit it through canvas. Submitting individual files for each problem or part of the problem will not be accepted and disregarded. There is no need to include big data files generated by your programs unless the data files are read by your programs (that is the program reads data from the file and uses that data). Email me any questions or concerns about the homework either through canvas or directly my email address.
Note: You are allowed to submit incomplete codes for partial credit.

Problem 1: Use Euler's method to solve the following equations for simple pendulum for a total time of 10 seconds.

$$\begin{aligned}\frac{d\omega}{dt} &= -\frac{g}{l}\vartheta \\ \frac{d\vartheta}{dt} &= \omega\end{aligned} \qquad (1)$$

Use l=1m, some arbitrary small values as initial conditions and a time-step of 0.04sec. Plot θ versus time. You will see that the amplitude is increasing with time. This is due to the low accuracy of Euler's method.

Problem 2: Repeat **Problem 1** with RK4 method to see how your answer improves.

Problem 3: Use RK3 method to solve

$$\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = sin(3x) \qquad (2)$$

over x = [0 100] using a step size of 0.01. Plot dy/dx versus x.

Problem 4: The growth of a biological population can be modeled over short periods of time by assuming that the population grows with time at rate proportional to the number at the initial time. If v represents the migration rate, then the rate of change of the population is given by

$$\frac{dN(t)}{dt} = \lambda N(t) + v \qquad (3)$$

Where $N(t)$ is the population at time t and λ is the birth rate. If the population at the beginning of the year (N_o) is one million, the population at the end of the year is 1.6 million, and v = 200,000/year. Use Shooting method to estimate the birth rate. Use h = 0.1day.