12/2-6 – Review for Final Exam

This is in approximate chronological order. As always, it does not include everything we covered. And I would say this collection of problems is tougher than the final will be. No one of them is too tough, but the total in aggregate would take too long. (There is also optional animation here. I will not have animation be part of the final.)

1. A particle of mass m has initial speed v_0 when it encounters a retarding force equal to $f = -mbv^2$, where m is the particle's mass and b is a positive constant. There are no other forces acting on the particle.

   (a) Write Newton's Second Law for this problem.

   (b) Substitute $a = \frac{dv}{dt}$ and use separation of variables to solve for v as a function of t.

   (c) You should now have $v(t)$. Do the same trick again, and integrate to get $x(t)$.

   (d) Write a structure plan for how you will calculate and plot $x(t)$.

   (e) Go to the computers and code it. Use values of $v_0 = 15$m/s, $x_0 = 0$, and $b = 1$ /m.

   (f) For the plot, please make this one Figure 1 and include a title and axis labels.

2. Use a `for` loop to find the first 10 terms of the Fibonacci sequence. Put the terms in a vector and then display the vector.

3. Use an `if` statement to determine if a given number is even or odd. Display the answer.

4. A projectile is launched with an initial speed of 5m/s at an angle of 36.87° with respect to the horizontal. Plot the trajectory of the particle (y vs x), and (optional) then animate it. This one should be Figure 2. Choose a time scale so that we see about a parabola for the trajectory. Optional: For the animation, make a red dot follow the trajectory.

5. For the previous problem, you probably made vectors for t, x and y. Write those out–as columns– to a text file called `YourName_projData.txt`. The first column should be t, second x, third y.

6. Write a function to find the sum of the first n terms of the series:

$$\frac{1!}{1} + \frac{2!}{2} + \frac{3!}{3} + \frac{4!}{4} + \cdots$$

   From the main script, call your function twice, for two different values of n. From there (not within the function) write your answers out to the command window.

7. I generated some random data around the function $y = 3x^3 + 2x + 6$. You can find the data in `reviewFinal2.txt` on the course web page under the 12/2 date. Read in the file and find the χ^2 from the least squares fitting method that we developed in class. (Use the function given above as the "fit.")

   Display your answer for χ^2 in the command window.

8. Yahtzee is a game where you roll 5 dice and try to get various combinations. A "straight" is when you get all five dice in a row, ie: 1, 2, 3, 4, 5 or 2, 3, 4, 5, 6. Run a simulation that shows the probability of getting a straight when you roll 5 dice.

   Display the probability in the command window.

9. Given the first order differential equation $\dot{x} = 5 - 4t$, and the initial conditions that the position of the object is at the origin when you start the clock: Use the Euler Method to approximate the solution for $x(t)$. (Do it yourself, don't use any built in MATLAB functions like `ode`.)

   In Figure 4: Plot the Euler approximation as circles and the exact solution as a line on the same graph. Title and label the axes, and include a legend.

10. Repeat the last problem, but use 2nd or 4th order Runge-Kutta to solve. Add the RK solution to the previous graph (Figure 4), as another data point, like '*'.