4/26 in Class – 2nd and 4th Order Runge-Kutta Approximations to ODE's

1. Use 2nd Order Runge-Kutta to find a numerical solution for $\dot{x} = 3t^2 + 1$ where x is in meters and t in seconds. At $t = 0$, $x = 0$. Run your approximation for 3s. Start with 10 time steps to check your work, and then try smaller intervals to see how your answer converges.
   (a) On the white board, write the equations you will use for $k1$, $k2$, $x(m+1)$, and $t(m+1)$. Substitute in everything (there should be no $\dot{x}$ in final version, for example.)
   (b) Then go back and write a MatLab program to do it for you.
   (c) Graph your calculated Runge-Kutta x, the Euler Method x, and the exact x as functions of time. Compare them.
   (d) Play around. Decrease the time step and/or increase the total time. What happens?
2. Use 2nd Order Runge-Kutta approximation to solve this DE: $\dot{N} = -\Gamma N$ where $\Gamma = 3.6\times10^{-4}$s. At $t = 0$, $N = 1000$. For the first pass, go from t=0 to 15,000 seconds with only 10 time steps. (That's just for debugging.)
   (a) Write the equations you will use–just as above–on the white board, plug things in.
   (b) Then write a MatLab program to do it for you.
   (c) Graph all three again: RK N, EM N, and the exact N as functions of time. Compare them.
   (d) Play around. Decrease the time step by a lot. What happens?
3. Repeat problem 1, but add in the 4th Order Runge-Kutta approximation.
4. Repeat problem 2, but add in the 4th Order Runge-Kutta approximation.