CH2013
Computational Programming and Simulations Lab
Aug-Dec 2019

Problem Sheet #6(a)

(Wednesday - Batch 1)

1. a) Represent the following polynomials in MATLAB. Label them p1, p2, and p3, respectively
   (i) $p1 = 4x^4 + 3.2x^2 - 4$
   (ii) $p2 = 4.6x^3 - 12x^2 + 10$
   (iii) $p3 = (x-1)(x-3)^2$

   b) Find the values of $p1, p2\ and\ p3$ at x=4.5; and label the results as value1, value2, and value3, respectively

   c) Find the roots of the polynomials and label the roots as r1, r2, and r3, respectively

2. Although fsolve is meant for systems of equations, it can also be used for a single f(x)=0 root finding problem as well. In this problem, we will examine the polynomial you worked with last week, again, but in three different ways

$$f(x) = x^3 - 10x^2 + 33x - 36$$

   a) Express *f(x)* as a polynomial **p** in your code. Find the roots and put them in a variable labelled '**rootsofp**'
   b) Now use **fzero** to solve the problem, use function tolerance of 1.e-2; x-tolerance of 1.e-2 and; and initial guess = 0. Save the values as xfinal1, ffinal1, iter1 (same as last week).
   c) Next use **fsolve** to solve the problem with the same tolerances & initial guess. Save the final values as xfinal2, ffinal2, and iter2. Note that you can use the same "myfun" code for this as in (b)
   d) If you use the MATLAB default tolerances for fzero and fsolve (instead of what is given here), do the roots change? Do this and put the answers in xfinal3, ffinal3 and iter3 (for fzero) and xfinal4, ffinal4 and iter4 (for fsolve).
   e) Overall what do you observe for this problem which has multiple roots, though it is a simple enough problem otherwise?

   (no submission for (e))

3. Import the data file given in Moodle. Import the data as arrays. Write a function file for plotting the data, with the following attributes: line width 2, grid on. The plotting function, should have the following input arguments: data used for plotting, xlabel, ylabel.

   a) Using the plot file function, plot the mass fraction of BioOil, CO, and A1CH3 as a function of time.
   b) What is the mass fraction of BioOil, CO and A1CH3 at t = 0.1, 0.2, 0.65, 0.9, 1
   c) Plot the above data as markers on the plot you have obtained for question A.
   d) Convert the mass fraction to mole fraction in the data file, using given molecular weights BioOil – 0.017008 Kg/mol, CO 0.02801 Kg/mol and A1CH3 0.092134 Kg/mol.

4. On February 25, 1991, during the Gulf War when a U.S. Patriot missile battery failed to intercept an incoming Iraqi Scud missile, which led to the Scud missile striking a barracks in Dhahran, Saudi

Arabia. This tragic incident resulted in the loss of lives, with 28 U.S. military personnel being killed and many others injured.

The primary cause of the failure was a software-related issue that led to inaccuracies in the system's internal clock and time calculations. The Patriot missile system used a floating-point representation for time calculations, and due to the continuous operation of the system over an extended period, a small but significant error accumulated in the system's time tracking. This error ultimately led to the system's inability to accurately track and intercept the incoming Scud missile.

The issues arose from a computer responsible for tracking calculations. This computer utilized an internal clock to generate integer values, which were then converted into real-time values through a binary arithmetic process. To achieve this conversion, the computer employed an approximation of 0.1, represented as

$0.1_{10} \approx 0.00011001100110011001100_2$,

which can be expressed as the ratio 209715/2097152.

The computed time values corresponded to time given in tenths of a second and was therefore calculated 10 times every second by the equivalent of the naive code

t = t + int*c
c = 209715/2097152

a) Find the accumulated error after 1 hour.
b) Find the accumulated error after 100 hours.
c) Plot the accumulated error in increment of 1-hour up to 100 Hours
d) Assuming it was Mach 0.8 missile which travels at a speed of 274 m/s, calculate the distance the Patriot missile missed the Scud missile