Aero 320: Numerical Methods

Lab Assignment 5

Fall 2013

Problem 1

Bisection method

Consider the n^{th} order Laguerre polynomial, which has the general form $L_n(x) = \dfrac{e^x}{n!}\dfrac{d^n}{dx^n}\left(e^{-x}x^n\right)$. For $n = 5$, the Laguerre polynomial of order 5 is

$$L_5(x) = \frac{1}{120}\left(-x^5 + 25x^4 - 200x^3 + 600x^2 - 600x + 120\right).$$

(a) Write a program in C++ that writes $L_5(x)$ to a file for x in the interval $[-2, 15]$.

(b) Import the data file generated in part (a) to MATLAB, and plot the function $L_5(x)$ versus x. In the plot, use vertical axis limits to be $[-15, 20]$. Visually confirm that the function has 5 roots when $x \in [-2, 15]$. Also, visually choose a good interval for each root to start the bisection method.

(c) Write a program that takes the initial interval and tolerance (from the keyboard or from a file) and gives the solution, which is the root found using the bisection method.

(d) Plot the value of x_i as a function of the iteration number i. Repeat this plot for each of the five roots.

Problem 2

More on bisection method

Consider the function $f(x) = 2\dfrac{\sin x}{x}$.

(a) Alter your code for Problem 1 to stop running the bisection method code after a fixed number of iterations.

(b) Consider $x \in [-2.2, 2]$ for $f(x)$. Run your bisection code and examine the output file. Did the bisection method find the root? Why/why not? (Hint: examine the plot of $f(x)$ in the given range of x.)