Assignment 2 (based upon Chapra 3rd edition)

ECE 2412 - Simulation and Engineering Analysis

Note . Submit your assignment in one word document that has the number of the question, the code for that question, and the output after running the code.

Problem 5.5. (a) Use the graphical method, determine the roots of:

$$f(x) = -12 - 21x + 18x^2 - 2.75x^3$$

In addition, determine the first root of the function with (b) bisection and (c) false position. Use initial guesses of $a = -1$ and $b = 0$ and a stopping criterion of 1% for both cases.

Problem 5.17. The charge Q is uniformly distributed around a ring-shaped conductor with radius a. A charge q is located at a distance x from the center of the ring. The force exerted on the charge by the ring is given by:

$$F = \frac{1}{4\pi e_0} \frac{qQx}{(x^2 + a^2)^{3/2}}$$

where $e_0 = 8.9 \times 10^{-12}\ C^2/(N\ m^2)$. Find the distance x where the force is $1.25N$ if q and Q are 2×10^{-5} C for a ring with a radius of 0.85 m. (Hint: modify the equation in order to solve it as a root problem).

Problem 6.1. Employ fixed-point iteration to locate the root of

$$f(x) = sin(\sqrt{x}) - x$$

Use an initial guess of $x_0 = 0.5$ and iterate until $\epsilon_a \leq 0.01\%$.

Problem 6.3. Determine the highest real root of $f(x) = x^3 - 6x^2 + 11x - 6.1$:

(a) Graphically.

(b) Using the Newton-Raphson method (three iterations, $x_i = 3.5$).

(c) Using the secant method (three iterations, $x_{i-1} = 2.5$ and $x_i = 3.5$).

(d) Using the modified secant method (three iterations, $x_i = 3.5$, $\delta = 0.01$).

(e) Determine all the roots with MATLAB.

Problem 6.24. In control systems analysis, transfer functions are developed that mathematically relate the dynamics of a system's input to its output. A transfer function for a robotic positioning system is given by:

$$G(s) = \frac{C(s)}{N(s)} = \frac{s^3 + 9s^2 + 26s + 24}{s^4 + 15s^3 + 77s^2 + 153s + 90}$$

where $G(s)$ is the system gain, $C(s)$ is the system output, $N(s)$ is the system input, and s is the Laplace transform complex frequency. Use MATLAB to find the roots of the numerator and denominator and factor these into the form:

$$G(s) = \frac{(s + a_1)(s + a_2)(s + a_3)}{(s + b_1)(s + b_2)(s + b_3)(s + b_4)}$$

where a_i and b_i are the roots of the numerator and denominator, respectively.

Problem 7.7. Employ the following methods to find the maximum of

$$f(x) = 4x - 1.8x^2 + 1.2x^3 - 0.3x^4$$

(a) Golden-section search ($a = 2$, $b = 4$, $\epsilon_s = 1\%$).

(b) Parabolic interpolation ($x_1 = 1.75$, $x_2 = 2$, $x_3 = 2.5$, iterations $= 5$).

Problem 7.23. Use the *fminsearch* function to determine the minimum of:

$$f(x, y) = 2y^2 - 2.25xy - 1.75y + 1.5x^2$$

Problem 7.24. Use the *fminsearch* function to determine the maximum of:

$$f(x, y) = 4x + 2y + x^2 - 2x^4 + 2xy - 3y^2$$