Programming Assignment 1: *Nonlinear Equations*

1. Write a computer program for finding a root of the non-linear equation, $f(x) = 0$, using the following methods:

   a. Bisection
   b. False-position
   c. Fixed-Point
   d. Newton-Raphson
   e. Secant

   The program should have the facility for providing the following input – (i) non-linear equation, (ii) option to choose one of the five methods mentioned above [for Fixed-Point method, also providing the $\phi(x)$; for Newton-Raphson method, also providing the $f'(x)$], (iii) starting values, and (iv) stopping criteria in form of maximum iterations and maximum relative approximate error (in %).

   It should provide as an output (i) Plot of $f(x)$ vs x, (ii) Plot of relative approximate error vs iteration number, and (iii) Roots of the equation.

   Test functions:

   (1) $\boldsymbol{f(x) = x - \cos x}$

   Use the initial bracket as (0,1) or the initial guess as 0; maximum iterations 50; and maximum ε_r= 0.01%. For Fixed-Point method, use $\phi(x)=\cos x$.

   (2) $\boldsymbol{f(x) = exp(-x) - x = 0}$

   Use the initial bracket as (0,1) or the initial guess as 0; maximum iterations 50; and maximum ε_r= 0.05%. For Fixed-Point method, use $\phi(x)=\exp(-x)$.

2. Write a computer program for finding roots of a polynomial $f(x)$ using the following methods: (a) Muller (b) Bairstow

   The program should have the facility for providing the following input – (i) polynomial, (ii) option to choose one of the two methods, (iii) starting values, and (iv) stopping criteria in form of maximum iterations and maximum relative approximate error (in %).

   It should provide as an output (i) Plot $f(x)$ vs x and (ii) Roots of the equation.

   Test polynomial:

   $f(x) = x^4 - 7.4x^3 + 20.44x^2 - 24.184x + 9.6448 = 0$

Muller method: Start with (−1,0,1) and then (0,1,2)
Bairstow method: Start with (α_0= −5, α_1= 4) and then (α_0= −2, α_1= 2)
Maximum iteration: 50
Maximum relative approximate error: 0.01%