ESO-208A
Computational Methods in Engineering
Assignment 1
2022-23 Semester-1

Due date: Friday, September 1, 2022, 11:59 pm

Submit a single zip folder in the Brihaspati server under Assignment-1. The name of the zip-folder should be your roll-number (e.g., If your roll no. is 123456, the folder name should be '123456.zip'). The folder should include-

(i) All the computer program file(s)
(ii) A PDF file of the plots and the solution of the test cases (given in the assignment). Comment on the convergence and stability of different methods.

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) $f(x) = x - \cos x$

   Use the initial bracket as (0,1) or the initial guess as 0; maximum iterations 50; and maximum $\varepsilon_r = 0.01\%$. 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 $\varepsilon_r = 0.05\%$. 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 $(\alpha_0 = -5, \alpha_1 = 4)$ and then $(\alpha_0 = -2, \alpha_1 = 2)$
   Maximum iteration: 50
   Maximum relative approximate error: 0.01%