INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS

MA635P-Scientific Programming Laboratory

Lab Exercise-7 (36 Marks) Deadline: 24 February 2026, 4:00 PM

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1. Create an algorithm for the Bisection method. [3]

2. Create an algorithm for the Regula-Falsi method. [3]

3. Create an algorithm for the Fixed Point Iteration method. [3]

4. Create an algorithm for the Newton-Raphson method. [3]

5. Write a Python code for the developed Bisection method and find the roots of the following equations. [5]

   (a) $x + 1 - 2\sin(\pi x) = 0, [0, 0.5]$ and $[0.5, 1]$
   (b) $x^3 - x - 2 = 0, [1, 2]$
   (c) $x - \frac{1}{2^x} = 0, [0, 1]$
   (d) $e^x - x^2 + 3x - 2 = 0, [0, 1]$
   (e) $\frac{x}{1+x^2} - 0.2, [0, 1]$

6. Write a Python code for the developed Regula-Falsi method and find the roots of the following equations **Caution**: Polynomials may have imaginary roots. [5]

   (a) $x^3 - 7x^2 + 14x - 6 = 0, [0, 1], [1, 3.2], [3.2, 4]$
   (b) $x^4 - 2x^3 - 4x^2 + 4x + 4 = 0, [-2, 1], [0, 2], [2, 3], [-1, 0]$
   (c) $x - \frac{1}{2^x} = 0, [0, 1]$
   (d) $e^x - x^2 + 3x - 2 = 0, [0, 1]$
   (e) $e^x - 2 = \cos(e^x - 2), [0.5, 1.5]$

7. Write a Python code for fixed point iteration method. Find all zeros (accurate within 10^{-5}) of $g(x) = x^2 + 10\cos x$ by using the fixed point method for the appropriate iteration function f. **Caution**: You should find a self-map f such that $|f'| \leq k < 1$ for the method to converge (definitely). [5]

   Hint: Contraction trick:

   Given equation

   $$g(x) = 0$$

   Define,

   $$f(x) = x - \lambda g(x)$$

$$\implies f'(x) = 1 - \lambda g'(x)$$

If we choose

$$0 < \lambda < \frac{2}{\max |g'(x)|}$$

then

$$f'(x) < 1$$

8. Are $|f'(x)| < 1$ and f a self-map a necessary condition? Check whether functions $f(x) = x/2$ and $f(x) = x - x^3$ satify these conditions? Check whether the fixed point method converges for $x_0 = 1.5$ and $x_0 = 0.001$ [4]

9. Write a Python code for the developed for Newton-Raphson method and find the roots of the following equations. Use sympy to compute the derivative. [5]

   (a) $x + 1 - 2\sin(\pi x) = 0, x_0 \in [0, 0.5]$

   (b) $x + 1 - 2\sin(\pi x) = 0, x_0 \in [0.5, 1]$

   (c) $x - \frac{1}{2^x} = 0, x_0 \in [0, 1]$

   (d) $e^x - x^2 + 3x - 2 = 0, x_0 \in [0, 1]$

   (e) $e^x - 2 = \cos(e^x - 2), x_0 \in [0.5, 1.5]$