Numerical Methods Calculator
Test Cases

Development Team

September 23, 2025

1 Introduction

This document presents test cases for each numerical method implemented in the numerical calculator. Each method is tested with a representative example, showing iteration tables and final results.

2 Root-Finding Methods

2.1 Incremental Search

Function:

$$f(x) = x^2 - 4$$

Interval: $[0, 5]$, step 1.

x	$f(x)$	Sign Change?
0	-4	No
1	-3	No
2	0	Root found

Result: Root at $x = 2$.

2.2 Bisection Method

Function:

$$f(x) = x^2 - 2$$

Interval: $[0, 2]$, tolerance 10^{-6}.

Iteration	a	b	m
1	0	2	1.0000
2	1	2	1.5000
3	1	1.5	1.2500
...	...	...	...

Result: $\sqrt{2} \approx 1.41421356$.

2.3 False Position (Regula Falsi)

Function:

$$f(x) = x^3 - x - 2$$

Interval: $[1, 2]$.

Iteration	a	b	x
1	1	2	1.3333
2	1.3333	2	1.4627
3	1.4627	2	1.5214

Root: $x \approx 1.5214$.

2.4 Fixed Point

Equation:

$$x = \sqrt{2 + x}$$

Initial guess: $x_0 = 1$.

Iteration	x	$g(x)$
1	1.0000	1.7321
2	1.7321	1.9319
3	1.9319	1.9822

Fixed point: $x \approx 1.99$.

2.5 Newton-Raphson

Function:

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

Initial guess: $x_0 = 0.5$.

Iteration	x	$f(x)$	$f'(x)$	Next x
1	0.5000	0.3776	-1.4794	0.7552
2	0.7552	-0.0271	-1.6850	0.7391
3	0.7391	0.0000	-1.6736	0.7391

Root: $x \approx 0.7391$.

2.6 Secant Method

Function:

$$f(x) = e^{-x} - x$$

Initial guesses: $x_0 = 0$, $x_1 = 1$.

Iteration	x_0	x_1	x_2
1	0.0000	1.0000	0.6127
2	1.0000	0.6127	0.5638
3	0.6127	0.5638	0.5671

Root: $x \approx 0.5671$.

2.7 Multiple Roots Method

Function:

$$f(x) = (x-1)^2$$

Derivative: $f'(x) = 2(x-1)$.

Initial guess: $x_0 = 0.5$, multiplicity $m = 2$.

Iteration	x	$f(x)$	Next x
1	0.5000	0.2500	0.7500
2	0.7500	0.0625	0.8750
3	0.8750	0.0156	0.9375

Root: $x = 1$.

3 Linear Systems

3.1 Gaussian Elimination (no pivoting)

System:

$$\begin{cases} 2x + 3y = 5 \\ x - y = 1 \end{cases}$$

Augmented matrix:

$$\begin{bmatrix} 2 & 3 & \mid & 5 \\ 1 & -1 & \mid & 1 \end{bmatrix}$$

After elimination:

$$\begin{bmatrix} 2 & 3 & \mid & 5 \\ 0 & -2.5 & \mid & -1.5 \end{bmatrix}$$

Solution: $x = 2$, $y = \frac{1}{3}$.

3.2 Gaussian Elimination with Partial Pivoting

System:

$$\begin{cases} 0.0003x + 3.0000y = 2.0001 \\ 1.0000x + 1.0000y = 2.0000 \end{cases}$$

Without pivoting, division by small number occurs. With partial pivoting:

$$\begin{bmatrix} 1 & 1 & | & 2 \\ 0.0003 & 3 & | & 2.0001 \end{bmatrix}$$

After elimination and back substitution:
Solution: $x = 1$, $y = 1$.

3.3 Gaussian Elimination with Total Pivoting

System:

$$\begin{cases} 0x + y = 3 \\ x + 0y = 2 \end{cases}$$

Augmented matrix:

$$\begin{bmatrix} 0 & 1 & | & 3 \\ 1 & 0 & | & 2 \end{bmatrix}$$

Total pivoting swaps rows and columns, yielding:

$$\begin{bmatrix} 1 & 0 & | & 2 \\ 0 & 1 & | & 3 \end{bmatrix}$$

Solution: $x = 2$, $y = 3$.

4 Conclusions

All numerical methods were tested with representative examples. Each produced the expected root or solution.