ME46002 Assignment 1

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# Q1

## Question:

Find the root(s) of the equations f(x)=0

by using the bisection method with a = 0.1 and b = 1.0  
The percentage relative error of the solutions should be less than 2%.

## Solution:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Iteration** | **a** | **b** | **c (root)** | **f(a)** | **f(c)** | **f(a) \* f(c)** | **error** |
| 1 | 0.1 | 1.0 | 0.55 | -0.110784393 | 0.0912977175 | -0.0101143622 | 81.8181818 |
| 2 | 0.1 | 0.55 | 0.325 | -0.110784393 | 0.0255795966 | -0.00283382009 | 69.2307692 |
| 3 | 0.1 | 0.325 | 0.2125 | -0.110784393 | -0.0327209091 | 0.00362496606 | 52.9411765 |
| 4 | 0.2125 | 0.325 | 0.26875 | -0.0327209091 | -0.00127828098 | 4.18265157e-5 | 20.9302326 |
| 5 | 0.26875 | 0.325 | 0.296875 | -0.00127828098 | 0.0127064063 | -1.62423575e-5 | 9.4736842 |
| 6 | 0.26875 | 0.296875 | 0.2828125 | -0.00127828098 | 0.00585498288 | -7.48431325e-6 | 4.97237568 |
| 7 | 0.26875 | 0.2828125 | 0.27578125 | -0.00127828098 | 0.00232384424 | -2.97052589e-6 | 2.54957507 |
| 8 | 0.26875 | 0.27578125 | 0.272265625 | -0.00127828098 | 0.000531688915 | -6.79647826e-7 | 1.2912482 |

**c = 0.272265625** where the error < 2%

# Q2

## Question:

Determine the root of the following equation

using bisection method with two initial guesses of a=0 and b=1. Perform the computation until the percentage relative error is less than 2%.

## Solution:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Iteration** | **a** | **b** | **c (root)** | **f(a)** | **f(c)** | **f(a) \* f(c)** | **error** |
| 1 | 0.0 | 1.0 | 0.5 | -1.0 | -0.339898117 | 0.339898117 | 100.0 |
| 2 | 0.5 | 1.0 | 0.75 | -0.339898117 | 0.122956118 | -0.0417925529 | 33.3333333 |
| 3 | 0.5 | 0.75 | 0.625 | -0.339898117 | -0.120074318 | 0.0408130345 | 20.0 |
| 4 | 0.625 | 0.75 | 0.6875 | -0.120074318 | -0.00162927498 | 0.000195634082 | 9.09090909 |
| 5 | 0.6875 | 0.75 | 0.71875 | -0.00162927498 | 0.059859121 | -9.75269682e-5 | 4.34782609 |
| 6 | 0.6875 | 0.71875 | 0.703125 | -0.00162927498 | 0.0289193564 | -4.71175838e-5 | 2.22222222 |
| 7 | 0.6875 | 0.703125 | 0.6953125 | -0.00162927498 | 0.0135967498 | -2.21528443e-5 | 1.12359551 |

**c = 0.6953125** where the error < 2%

# Q3

## Solution:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Iteration** | **xi** | **f(x)** | **dF(x)** | **x** | **error** |
| 1 | 2 | 5.80520293547779 | 4.63458410512678 | 1.30043918742921 | 53.7941965555289 |
| 2 | 1.30043918742921 | 1.40383291032124 | 4.63458410512678 | 0.99753543630981 | 30.3652121111539 |
| 3 | 0.99753543630981 | 0.169216176822879 | 3.55172751964363 | 0.949892092081687 | 5.01565858114605 |
| 4 | 0.949892092081687 | 0.0036597957717972 | 3.3987833876652 | 0.94881529625378 | 0.113488455778316 |
| 5 | 0.94881529625378 | 1.83579942580891e-6 | 3.39537398522268 | 0.948814755577132 | 5.69844266283453e-5 |

**x = 0.948814755577132** where the error < 0.1%

# Q4i

## Solution:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Iteration** | | **xi** | **f(x)** | **dF(x)** | **x** | **error** |
| 1 | 0.5 | | -3.375 | 506.0 | -13.0 | 103.846153846154 |
| 2 | -13.0 | | -2187.0 | 506.0 | -8.67786561264822 | 49.8064222272831 |
| 3 | -8.67786561264822 | | -647.811855408859 | 224.916054773548 | -5.79762722299171 | 49.679606481671 |
| 4 | -5.79762722299171 | | -192.075010071203 | 99.8374442503237 | -3.8737497488287 | 49.6644749636895 |
| 5 | -3.8737497488287 | | -57.2554953873476 | 44.0178113496512 | -2.57301503186278 | 50.5529389007971 |
| 6 | -2.57301503186278 | | -17.4613900345127 | 18.8612190625755 | -1.64723234641804 | 56.2023133808588 |
| 7 | -1.64723234641804 | | -5.82232573828777 | 7.14012320925765 | -0.831794633699199 | 98.0335385301039 |
| 8 | -0.831794633699199 | | -2.74370936111512 | 1.07564693795236 | 1.71895809408539 | 148.389465488498 |
| 9 | 1.71895809408539 | | 0.360248382940782 | 7.86445078766507 | 1.67315090517071 | 2.73777988423625 |
| 10 | 1.67315090517071 | | 0.0107245447029332 | 7.39830185442074 | 1.67170130972111 | 0.0867137832081673 |

**x = 1.67170130972111** where the error < 0.1%

# Q4ii

## Solution:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Iteration** | **xi** | **f(x)** | **dF(x)** | **x** | **error** |
| 1 | 0.0 | -3.0 | 26.0 | -3.0 | 100.0 |
| 2 | -3.0 | -27.0 | 26.0 | -1.96153846153846 | 52.9411764705882 |
| 3 | -1.96153846153846 | -8.58574192080109 | 10.542899408284 | -1.14717596140355 | 70.9884557848091 |
| 4 | -1.14717596140355 | -3.36252215736205 | 2.94803805926645 | -0.00657937148071208 | 17335.9506035885 |
| 5 | -0.00657937148071208 | -2.99342091332797 | -0.999870135612756 | -3.00038907407123 | 99.7807160565418 |
| 6 | -3.00038907407123 | -27.0101172883186 | 26.0070037874181 | -1.96181817566632 | 52.9392025870166 |
| 7 | -1.96181817566632 | -8.58869137914838 | 10.5461916631242 | -1.1474302284816 | 70.9749426997757 |
| 8 | -1.1474302284816 | -3.36327196890261 | 2.94978838770003 | -0.00725624755242338 | 15712.997285331 |
| 9 | -0.00725624755242338 | -2.99274413451171 | -0.999842040614374 | -3.00047318877322 | 99.7581632264013 |

**Cannot find solution with initial guess = 0** because the second derivative of f(x) at 0 is 0, thus the point where x = 0 is an inflection point causing the subsequent calculations to diverge.