# EE 457 HW 2

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**Question 1-**

a) Results for Golden Section Method:

```
Iteration Number: 1, Uncertainty Interval: [1.000, 4.090], Function Value: 8.2527
Iteration Number: 2, Uncertainty Interval: [2.180, 4.090], Function Value: 8.2527
Iteration Number: 3, Uncertainty Interval: [2.180, 3.361], Function Value: 8.2527
Iteration Number: 4, Uncertainty Interval: [2.180, 2.910], Function Value: 8.2382
Iteration Number: 5, Uncertainty Interval: [2.459, 2.910], Function Value: 8.2382
Iteration Number: 6, Uncertainty Interval: [2.631, 2.910], Function Value: 8.2357
Iteration Number: 7, Uncertainty Interval: [2.631, 2.803], Function Value: 8.2357
Iteration Number: 8, Uncertainty Interval: [2.631, 2.738], Function Value: 8.2354
Iteration Number: 9, Uncertainty Interval: [2.672, 2.738], Function Value: 8.2354
Iteration Number: 10, Uncertainty Interval: [2.697, 2.738], Function Value: 8.2353
Iteration Number: 11, Uncertainty Interval: [2.697, 2.722], Function Value: 8.2353
Iteration Number: 12, Uncertainty Interval: [2.697, 2.712], Function Value: 8.2353

Final Uncertainty Interval Length: 0.0155

Elapsed time is 0.196532 seconds.
```

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b) Results for Fibonacci Method:

```
Iteration Number: 1, Uncertainty Interval: [1.000, 4.090], Function Value: 8.2527
Iteration Number: 2, Uncertainty Interval: [2.180, 4.090], Function Value: 8.2527
Iteration Number: 3, Uncertainty Interval: [2.180, 3.361], Function Value: 8.2527
Iteration Number: 4, Uncertainty Interval: [2.180, 2.910], Function Value: 8.2382
Iteration Number: 5, Uncertainty Interval: [2.459, 2.910], Function Value: 8.2382
Iteration Number: 6, Uncertainty Interval: [2.631, 2.910], Function Value: 8.2357
Iteration Number: 7, Uncertainty Interval: [2.631, 2.804], Function Value: 8.2357
Iteration Number: 8, Uncertainty Interval: [2.631, 2.737], Function Value: 8.2354
Iteration Number: 9, Uncertainty Interval: [2.671, 2.737], Function Value: 8.2354
Iteration Number: 10, Uncertainty Interval: [2.698, 2.737], Function Value: 8.2353
Iteration Number: 11, Uncertainty Interval: [2.698, 2.724], Function Value: 8.2353
Iteration Number: 12, Uncertainty Interval: [2.698, 2.711], Function Value: 8.2353

Final Uncertainty Interval Length: 0.0133

Elapsed time is 0.020738 seconds.
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c) As can be seen from the above iterations, Fibonacci method ends up with a smaller final uncertainty interval although both methods use the same number of iterations. Additionally, elapsed time during the run of Fibonacci method is also smaller. Although this time measurement may change from case to case, it is important to note that Fibonacci method does not need long calculation times for achieving better uncertainty intervals.

**Question 2-**

a) Results for Golden Section Method

```
Iteration Number: 1, Uncertainty Interval: [0.500, 1.427], Function Value: 0.1685
Iteration Number: 2, Uncertainty Interval: [0.854, 1.427], Function Value: 0.1685
Iteration Number: 3, Uncertainty Interval: [0.854, 1.208], Function Value: 0.1685
Iteration Number: 4, Uncertainty Interval: [0.854, 1.073], Function Value: 0.0974
Iteration Number: 5, Uncertainty Interval: [0.938, 1.073], Function Value: 0.0974
Iteration Number: 6, Uncertainty Interval: [0.989, 1.073], Function Value: 0.0824
Iteration Number: 7, Uncertainty Interval: [0.989, 1.041], Function Value: 0.0824
Iteration Number: 8, Uncertainty Interval: [0.989, 1.021], Function Value: 0.0823
Iteration Number: 9, Uncertainty Interval: [1.002, 1.021], Function Value: 0.0823

Final Uncertainty Interval Length: 0.0197

Elapsed time is 0.178744 seconds.
```

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b) Results for Newton's Method

```
Iteration Number: 1, X Value: 0.5000, Function Value: 3.9696
Iteration Number: 2, X Value: -1.1775, Function Value: 0.8235
Iteration Number: 3, X Value: -1.0386, Function Value: 0.0955
Iteration Number: 4, X Value: -1.0157, Function Value: 0.0815
Iteration Number: 5, X Value: -1.0150, Function Value: 0.0814

Elapsed time is 0.017385 seconds.
```

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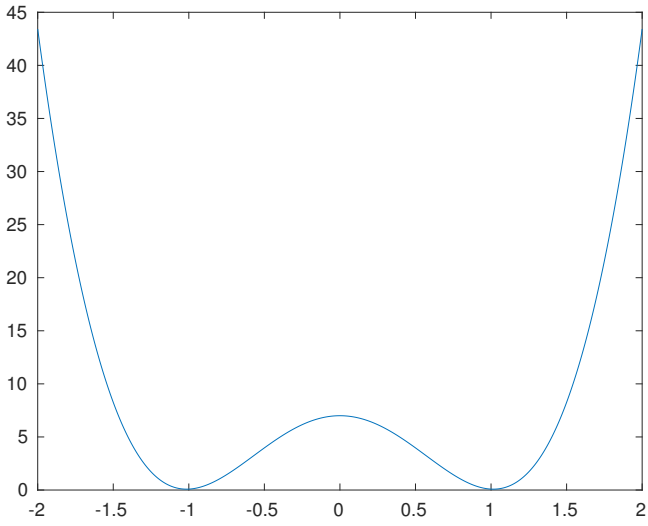
c) Both algorithms find similar values for the minimum of the function. However, the location of those minimums are completely different. Golden section method claims that the minimum is somewhere between [1.002, 1.021], whereas Newton's method claims that x=-1.0150 is the point where the function achieves its minimum. The difference stems from the working principle of Newton's method. In order to expect a true result from Newton's method, it should be satified that the second derivative of the function is always positive on the working interval. As can be seen from the below figure, this function has negative second derivative values for the interval [-1,1]. For example, starting with initial values greater than x=1 provides the same results with Golden section method. Therefore, starting point should be carefully chosen while using Newton's method.



**Question 3-**

a)

```
Iteration Number: 1, X Value: 3.0000 Function Value: 492.0000
Iteration Number: 2, X Value: 0.0182 Function Value: -2.9455
Iteration Number: 3, X Value: 0.0359 Function Value: -2.8922
Iteration Number: 4, X Value: 1.0000 Function Value: 2.0000
Iteration Number: 5, X Value: 0.6059 Function Value: -1.0191
Iteration Number: 6, X Value: 0.7389 Function Value: -0.3427
Iteration Number: 7, X Value: 0.8063 Function Value: 0.1006
Iteration Number: 8, X Value: 0.7910 Function Value: -0.0075
Iteration Number: 9, X Value: 0.7921 Function Value: -0.0002
Iteration Number: 10, X Value: 0.7921 Function Value: 0.0000

Root is at x= 0.7921

Elapsed time is 0.004497 seconds.
```