

# Numeric Analysis - Final Project

## Finding Equation Roots + Numerical Integration

### Question 4

• שאלה מס' 4

עבור הפונקציה הבאה

$$f(x) = \frac{\sin(2x^3 + 5x^2 - 6)}{2e^{-2x}}$$

1. מצאו באמצעות שתי שיטות את כל השורשים האמיטיים הנמצאים בקטע  $[-1, 1.5]$
2. השתמשו בקירוב סימפסון ו בשיטת רומברג למציאת הערך של האינטגרל בקטע  $[0, 1]$

GitHub: <https://github.com/Maor-Ar/Numerical-Analysis-Hackathon/blob/main/Q4%20Finding%20Equation%20Roots%20Numerical%20Integration.py>

פתרונות

הרצאה של השיטות על הפונקציה הנדרשת

```
def MainFunction():

    roots = []
    checkRange = frange(-1, 1.6, 0.1)
    epsilon = 0.00001
    n = 18

    def func(val):
        return lambdify(x, my_f)(val)

    print(bcolors.OKBLUE,"Finding roots of the equation f(X) = sin(2X³+5X²-6) / 2e^-2X\n",bcolors.ENDC)
    print(bcolors.OKGREEN, "\nNewton Raphson Method",bcolors.ENDC)
    roots += NewtonsMethodInRangeIterations(my_f, checkRange, 10, 0.000001)
    print("\nThere are ", bcolors.OKBLUE, len(roots), "roots found by Newton Raphson Method", bcolors.ENDC)
    printFinalResult(roots)
    roots.clear()

    print(bcolors.OKGREEN, "\nSecant Method", bcolors.ENDC)
    roots += SecantMethodInRangeIterations(func, checkRange, 0.0000001)
    print("\nThere are ", bcolors.OKBLUE, len(roots), "roots found by Secant Method", bcolors.ENDC)
    printFinalResult(roots)
```

פלט סופי: (ופלט של האיטרציות)

```
There are 6 roots found by Newton Raphson Method
-0.96488800000132311
0.67131600000132311
1.27543200000132311
0.93459400000132311
1.12318400000132311
1.27543200000132311
1.40529500000132311
```

```
There are 6 roots found by Secant Method
-0.96488800000132311
0.67131600000132311
0.93459400000132311
1.12318400000132311
1.27543200000132311
1.40529500000132311
```

Finding roots of the equation  $f(x) = \sin(2x^3+5x^2-6) / 2e^{x-2}$

**Newton Raphson Method**

First guess: -1.0

Attempt # 1 :

```
f(-1.0) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.00
f'(-1.0) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.25
next_X = -0.96
```

Attempt # 2 :

```
f(-0.961628502837890) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.961628502837890) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.38
next_X = -0.96
```

Attempt # 3 :

```
f(-0.964865469809108) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964865469809108) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Attempt # 4 :

```
f(-0.96488398350864) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.96488398350864) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Found a Root Solution ; X = -0.96488840

First guess: -0.9

Attempt # 1 :

```
f(-0.9) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.02
f'(-0.9) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.37
next_X = -0.96
```

Attempt # 2 :

```
f(-0.958238681129194) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.958238681129194) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.38
next_X = -0.96
```

Attempt # 3 :

```
f(-0.964794636243799) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964794636243799) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.38
next_X = -0.96
```

Attempt # 4 :

```
f(-0.964888380222631) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964888380222631) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Found a Root Solution ; X = -0.96488840

Already found that root.

First guess: -0.8

Attempt # 1 :

```
f(-0.8) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.06
f'(-0.8) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.45
next_X = -0.94
```

Attempt # 2 :

```
f(-0.940468174782906) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.01
f'(-0.940468174782906) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.33
next_X = -0.96
```

Attempt # 3 :

```
f(-0.95373222441117) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.95373222441117) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.38
next_X = -0.96
```

Attempt # 4 :

```
f(-0.964885488796346) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964885488796346) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Attempt # 5 :

```
f(-0.96488399485826) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.96488399485826) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Found a Root Solution ; X = -0.96488840

Already found that root.

First guess: -0.7

Attempt # 1 :

```
f(-0.7) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.11
f'(-0.7) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.45
next_X = -0.94
```

Attempt # 2 :

```
f(-0.94419543845507) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.01
f'(-0.94419543845507) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.32
next_X = -0.96
```

Attempt # 3 :

```
f(-0.964043139817001) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964043139817001) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.38
next_X = -0.96
```

Attempt # 4 :

```
f(-0.964868638599141) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964868638599141) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Attempt # 5 :

```
f(-0.96488399499070) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.96488399499070) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Found a Root Solution ; X = -0.96488840

Already found that root.

First guess: -0.6

Attempt # 1 :

```
f(-0.6) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.15
f'(-0.6) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.35
next_X = -1.03
```

Attempt # 2 :

```
f(-1.0330203375058) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.02
f'(-1.0330203375058) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.21
next_X = -0.95
```

Attempt # 3 :

```
f(-0.95085612499351) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.95085612499351) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.31
next_X = -0.96
```

Attempt # 4 :

```
f(-0.96444108884414) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.96444108884414) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.30
next_X = -0.96
```

Attempt # 5 :

```
f(-0.964887961313182) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964887961313182) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
```

Found a Root Solution ; X = -0.96488840

Already found that root.

First guess: -0.5

Attempt # 1 :

```
f(-0.5) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.18
f'(-0.5) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.17
next_X = -1.54
```

Attempt # 2 :

```
f(-1.53664026190978) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.02
f'(-1.53664026190978) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.05
next_X = -2.08000000000000
```

Attempt # 3 :

```
f(-2.028616947402) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.09
f'(-2.028616947402) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.05
next_X = -2.26
```

Attempt # 4 :

```
f(-2.25891084582205) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.25891084582205) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.29
```

Attempt # 5 :

```
f(-2.20040244375879) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.20040244375879) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.21
```

Attempt # 6 :

```
f(-2.20640120729432) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.20640120729432) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.21
```

Attempt # 7 :

```
f(-2.2064288029235) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.2064288029235) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.21
```

Found a Root Solution ; X = -2.20642883

root out of range.

First guess: -0.4

Attempt # 1 :

```
f(-0.4) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.18
f'(-0.4) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.03
next_X = -6.26
```

Attempt # 2 :

```
f(-6.2576367649347) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 130489.76
f'(-6.2576367649347) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 11906378.23
next_X = -6.25
```

Attempt # 3 :

```
f(-6.24667711442320) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -122472.73
f'(-6.24667711442320) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -15837859.83
next_X = -6.24
```

Attempt # 4 :

```
f(-6.23894420519986) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 118446.40
f'(-6.23894420519986) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -16485323.17
next_X = -6.25
```

Attempt # 5 :

```
f(-6.24612916590128) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -112230.22
f'(-6.24612916590128) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -21462273.97
next_X = -6.24
```

Attempt # 6 :

```
f(-6.24089949804307) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 68494.78
f'(-6.24089949804307) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -33187610.55
next_X = -6.24
```

Attempt # 7 :

```
f(-6.24296384686335) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -8536.89
f'(-6.24296384686335) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -39131822.33
next_X = -6.24
```

Attempt # 8 :

```
f(-6.2427456847193) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 7.89
f'(-6.2427456847193) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -39176877.05
next_X = -6.24
```

Found a Root Solution ; X = -6.2427456847193

root out of range.

```

First guess: -0.3
Attempt # 1 :
f(-0.3) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.17
f'(-0.3) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.18
next_X = 0.65
Attempt # 2 :
f(0.654983569402962) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.28
f'(0.654983569402962) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.15
next_X = 0.67
Attempt # 3 :
f(0.672285121238158) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.02
f'(0.672285121238158) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.13
next_X = 0.67
Attempt # 4 :
f(0.671319166558960) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.671319166558960) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Attempt # 5 :
f(0.671316425427875) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.671316425427875) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Found a Root Solution ; X = 0.67131643
First guess: -0.2
Attempt # 1 :
f(-0.2) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.15
f'(-0.2) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.22
next_X = 0.47
Attempt # 2 :
f(0.471552502191544) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.28
f'(0.471552502191544) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 2.38
next_X = -0.09
Attempt # 3 :
f(-0.08856168153183088) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.13
f'(-0.08856168153183088) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.06
next_X = 2.08
Attempt # 4 :
f(2.07632363101966) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 28.33
f'(2.07632363101966) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -616.81
next_X = 2.12
Attempt # 5 :
f(2.12225684975514) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -39.74
f'(2.12225684975514) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -854.91
next_X = 2.09
Attempt # 6 :
f(2.08630108369314) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 19.17
f'(2.08630108369314) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -1191.06
next_X = 2.18
Attempt # 7 :
f(2.1024003597103) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -4.29
f'(2.1024003597103) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -1588.37
next_X = 2.20
Attempt # 8 :
f(2.09969727701103) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(2.09969727701103) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -1581.16
next_X = 2.10
Attempt # 9 :
f(2.09969484937525) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(2.09969484937525) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -1581.16
next_X = 2.10
Found a Root Solution ; X = 2.09969485
root out of range.
First guess: -0.1
Attempt # 1 :
f(-0.1) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.13
f'(-0.1) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.1
next_X = 1.26
Attempt # 2 :
f(1.26285383505702) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -1.73
f'(1.26285383505702) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 129.82
next_X = 1.28
Attempt # 3 :
f(1.27621323717675) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.11
f'(1.27621323717675) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.85
next_X = 1.28
Attempt # 4 :
f(1.27543315158511) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.27543315158511) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.30
next_X = 1.28
Attempt # 5 :
f(1.275433167297513) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.275433167297513) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.30
next_X = 1.28
Found a Root Solution ; X = 1.27543167
First guess: 0.0
Attempt # 1 :
f(0.0) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.14
f'(0.0) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.28
next_X = -0.50
Attempt # 2 :
f(-1.500000000000000) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.18
f'(-1.500000000000000) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.17
next_X = -1.54
Attempt # 3 :
f(-1.5366492619978) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.02
f'(-1.5366492619978) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.05
next_X = -2.06
Attempt # 4 :
f(-2.00286168947402) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.00
f'(-2.00286168947402) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.03
next_X = -2.26
Attempt # 5 :
f(-2.25891084582285) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.25891084582285) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.20
Attempt # 6 :
f(-2.20840244375879) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.20840244375879) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.21
Attempt # 7 :
f(-2.20642802529236) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.20642802529236) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -2.21
Found a Root Solution ; X = -2.20642803
root out of range.
First guess: 0.1
Attempt # 1 :
f(0.1) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.20
f'(0.1) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 1.01
next_X = -0.1
Attempt # 2 :
f(-0.098290694815215) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.13
f'(-0.098290694815215) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.09
next_X = 1.32
Attempt # 3 :
f(1.32223717222573) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 6.21
f(1.32223717222573) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 90.83
next_X = 1.25
Attempt # 4 :
f(1.25383430786461) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -2.84
f(1.25383430786461) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 113.92
next_X = 1.28
Attempt # 5 :
f(1.2787325132341) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.48
f(1.2787325132341) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 146.35
next_X = 1.28
Attempt # 6 :
f(1.27545332356527) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f(1.27545332356527) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.31
next_X = 1.28
Attempt # 7 :
f(1.27543167146893) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f(1.27543167146893) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.30
next_X = 1.28
Found a Root Solution ; X = 1.27543167
Already found that root.
First guess: 0.2
Attempt # 1 :
f(0.2) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.36
f'(0.2) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 2.18
next_X = 0.04
Attempt # 2 :
f(-0.272061678687955) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.17
f'(-0.272061678687955) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.21
next_X = 0.54
Attempt # 3 :
f(0.05521865334597) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.31
f(0.05521865334597) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -2.00000000000000
next_X = -0.27
Attempt # 4 :
f(1.29196946866623) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 2.43
f(1.29196946866623) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 146.19
next_X = 1.28
Attempt # 5 :
f(1.27533792381867) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.22
f(1.27533792381867) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -38.72
next_X = 1.06
Attempt # 6 :
f(1.05521865334597) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 3.88
f(1.05521865334597) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -16.39
next_X = 1.29
Attempt # 7 :
f(1.27533792381867) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.01
f(1.27533792381867) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.23
next_X = 1.28
Attempt # 8 :
f(1.27543167297513) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f(1.27543167297513) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.30
next_X = 1.28
Found a Root Solution ; X = 1.27543167
Already found that root.

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First guess: 0.3
Attempt # 1 :
f(0.3) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.65
f'(0.3) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 3.57
next_X = 0.12
Attempt # 2 :
f(0.119822117568839) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.22
f'(0.119822117568839) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 1.28
next_X = -0.07
Attempt # 3 :
f(-0.0655570897738426) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.13
f'(-0.0655570897738426) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.8
next_X = 149.89
Attempt # 4 :
f(149.892771083585) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 4.52784618752768E+129
f'(149.892771083585) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 8.72005662915668E+11
next_X = 149.89
Attempt # 5 :
f(149.892771083585) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -7.18708761061710E+128
f'(149.892771083585) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 1.0379227627052E+11
next_X = 149.89
Found a Root Solution ; X = 149.89277168
root out of range.
First guess: 0.4
Attempt # 1 :
f(0.4) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.04
f'(0.4) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 4.03
next_X = 0.14
Attempt # 2 :
f(0.141251437891501) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.25
f'(0.141251437891501) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 1.44
next_X = -0.03
Attempt # 3 :
f(-0.0328846948513160) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.13
f'(-0.0328846948513160) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.12
next_X = -1.13
Attempt # 4 :
f(-1.12709946608489) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.03
f'(-1.12709946608489) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.09
next_X = -0.79
Attempt # 5 :
f(-0.79458299762425) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.07
f'(-0.79458299762425) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.46
next_X = -0.94
Attempt # 6 :
f(-0.939784434804916) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.01
f'(-0.939784434804916) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.33
next_X = -0.96
Attempt # 7 :
f(-0.963671842966791) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.963671842966791) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.30
next_X = -0.96
Attempt # 8 :
f(-0.964885172284401) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964885172284401) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
Attempt # 9 :
f(-0.964883599481563) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-0.964883599481563) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.29
next_X = -0.96
Found a Root Solution ; X = -0.9648840
Already found that root.
First guess: 0.5
Attempt # 1 :
f(0.5) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.33
f'(0.5) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.79
next_X = -1.17
Attempt # 2 :
f(-1.1713294895778) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.33
f'(-1.1713294895778) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.05
next_X = -0.49
Attempt # 3 :
f(-0.498992277214172) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.18
f'(-0.498992277214172) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 0.15
next_X = -1.68
Attempt # 4 :
f(-1.6792253465677) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.02
f'(-1.6792253465677) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.03
next_X = -0.19
Attempt # 5 :
f(-2.1857864476066) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.1857864476066) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -0.21
Attempt # 6 :
f(-2.2062154410743) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.2062154410743) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -0.21
Attempt # 7 :
f(-2.206422798747706) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(-2.206422798747706) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.04
next_X = -0.21
Found a Root Solution ; X = -2.20642803
root out of range.
First guess: 0.6
Attempt # 1 :
f(0.6) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.97
f'(0.6) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -9.03
next_X = 0.71
Attempt # 2 :
f(0.707798871772479) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.72
f'(0.707798871772479) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -20.90
next_X = 0.67
Attempt # 3 :
f(0.67348849193905) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.04
f'(0.67348849193905) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.28
next_X = 0.67
Attempt # 4 :
f(0.671329988890175) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.671329988890175) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Attempt # 5 :
f(0.671316425949848) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.671316425949848) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Found a Root Solution ; X = 0.671316425949848
Already found that root.
First guess: 0.7
Attempt # 1 :
f(0.7) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.56
f'(0.7) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -20.49
next_X = 0.67
Attempt # 2 :
f(0.672887493213409) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.03
f'(0.672887493213409) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.26
next_X = 0.67
Attempt # 3 :
f(0.671325578359422) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.671325578359422) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Attempt # 4 :
f(0.671316425557018) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.671316425557018) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Found a Root Solution ; X = 0.671316425557018
Already found that root.
First guess: 0.8
Attempt # 1 :
f(0.8) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -2.42
f'(0.8) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -10.82
next_X = 0.58
Attempt # 2 :
f(0.576006532666031) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.15
f'(0.576006532666031) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -6.08
next_X = 0.77
Attempt # 3 :
f(0.76516651714284) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -1.91
f'(0.76516651714284) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.40
next_X = 0.66
Attempt # 4 :
f(0.661982846728122) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.16
f'(0.661982846728122) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -16.99
next_X = 0.67
Attempt # 5 :
f(0.6716673823341) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.00
f'(0.6716673823341) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -18.03
next_X = 0.67
Found a Root Solution ; X = 0.6716673823341
Already found that root.
First guess: 0.9
Attempt # 1 :
f(0.9) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.00
f'(0.9) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -0.00
next_X = 0.94
Attempt # 2 :
f(0.941910896002132) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.35
f'(0.941910896002132) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 48.92
next_X = 0.93
Attempt # 3 :
f(0.934709675425358) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.01
f'(0.934709675425358) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.31
next_X = 0.93
Attempt # 4 :
f(0.934593913961140) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.934593913961140) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.28
next_X = 0.93
Found a Root Solution ; X = 0.934593913961140
Already found that root.
First guess: 1.0
Attempt # 1 :
f(1.0) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 3.11
f'(1.0) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 38.16
next_X = 0.92
Attempt # 2 :
f(0.918523528056812) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.72
f'(0.918523528056812) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 42.89
next_X = 0.94
Attempt # 3 :
f(0.935649503502164) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.05
f'(0.935649503502164) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.55
next_X = 0.93
Attempt # 4 :
f(0.934596824392551) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.934596824392551) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.28
next_X = 0.93
Attempt # 5 :
f(0.934593877537313) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.934593877537313) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.28
next_X = 0.93
Found a Root Solution ; X = 0.934593877537313
Already found that root.

```

```

First guess: 1.1
Attempt # 1 :
f(1.1) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.88
f'(1.1) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -71.15
next_X = 1.13
Attempt # 2 :
f(1.12641460202790) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.29
f'(1.12641460202790) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -90.22
next_X = 1.12
Attempt # 3 :
f(1.12320684637456) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.12320684637456) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -88.88
next_X = 1.12
Attempt # 4 :
f(1.12318362461434) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.12318362461434) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -88.87
next_X = 1.12
Found a Root Solution ; X = 1.12318362
First guess: 1.2
Attempt # 1 :
f(1.2) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -5.50
f'(1.2) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -17.42
next_X = 0.88
Attempt # 2 :
f(0.884054587340345) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -1.91
f'(0.884054587340345) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 26.23
next_X = 0.96
Attempt # 3 :
f(0.956891334441057) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.10
f'(0.956891334441057) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 50.49
next_X = 0.94
Attempt # 4 :
f(0.935103840093767) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.02
f'(0.935103840093767) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.41
next_X = 0.93
Attempt # 5 :
f(0.934594576346550) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(0.934594576346550) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 47.28
next_X = 0.93
Found a Root Solution ; X = 0.93459459388
Already found that root.
First guess: 1.3
Attempt # 1 :
f(1.3) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 3.58
f'(1.3) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 139.08
next_X = 1.27
Attempt # 2 :
f(1.27425476892170) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.17
f'(1.27425476892170) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 143.38
next_X = 1.28
Attempt # 3 :
f(1.27543550644470) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.27543550644470) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.30
next_X = 1.28
Attempt # 4 :
f(1.27543167030721) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.27543167030721) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 144.30
next_X = 1.28
Found a Root Solution ; X = 1.27543167
Already found that root.
First guess: 1.4
Attempt # 1 :
f(1.4) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.12
f'(1.4) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -207.59
next_X = 1.41
Attempt # 2 :
f(1.4054007782019) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -0.02
f'(1.4054007782019) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -215.36
next_X = 1.41
Attempt # 3 :
f(1.40529513470523) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.40529513470523) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = -215.24
next_X = 1.41
Found a Root Solution ; X = 1.40529511
First guess: 1.5
Attempt # 1 :
f(1.5) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = -5.39
f'(1.5) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 230.75
next_X = 1.52
Attempt # 2 :
f(1.52335292296574) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 1.12
f'(1.52335292296574) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 307.31
next_X = 1.52
Attempt # 3 :
f(1.51970121793754) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.01
f'(1.51970121793754) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 303.52
next_X = 1.52
Attempt # 4 :
f(1.51968182985972) = exp(2*x)*sin(2*x**3 + 5*x**2 - 6)/2 = 0.0
f'(1.51968182985972) = (6*x**2 + 10*x)*exp(2*x)*cos(2*x**3 + 5*x**2 - 6)/2 + exp(2*x)*sin(2*x**3 + 5*x**2 - 6) = 303.49
next_X = 1.52
Found a Root Solution ; X = 1.51968183
root out of range.

```

**Secant Method**

Checked range: -1.0 - -0.9

iteration no. 0 Xi = -1.0 Xi+1 = -0.9 f(Xi) = -0.009549258130567598  
 iteration no. 1 Xi = -0.9 Xi+1 = -0.964991282090831 f(Xi) = 0.02175889029926127  
 iteration no. 2 Xi = -0.964991282090831 Xi+1 = -0.9654503173307634 f(Xi) = -0.0013462822791995273  
 iteration no. 3 Xi = -0.9654503173307634 Xi+1 = -0.9648823678813071 f(Xi) = -0.0001655174224266507  
 iteration no. 4 Xi = -0.9648823678813071 Xi+1 = -0.964884066187469 f(Xi) = 1.699249593488368e-06  
 after 5 iterations The root found is: -0.964888

Checked range: -0.9 - -0.8

iteration no. 0 Xi = -0.9 Xi+1 = -0.8 f(Xi) = 0.02175889029926127  
 iteration no. 1 Xi = -0.8 Xi+1 = -0.9519237705494638 f(Xi) = 0.06366434065431437  
 iteration no. 2 Xi = -0.9519237705494638 Xi+1 = -0.96192368906461 f(Xi) = -0.00593172123429532  
 iteration no. 3 Xi = -0.96192368906461 Xi+1 = -0.96488074490669934 f(Xi) = -0.0008800360652295097  
 iteration no. 4 Xi = -0.96488074490669934 Xi+1 = -0.9648878770168308 f(Xi) = 2.38782872778807842e-05  
 iteration no. 5 Xi = -0.9648878770168308 Xi+1 = -0.964883994116273 f(Xi) = 1.5409314290100325e-07  
 after 6 iterations The root found is: -0.964888

Already found that root.

Checked range: -0.8 - -0.7

iteration no. 0 Xi = -0.8 Xi+1 = -0.7 f(Xi) = 0.06366434065431437  
 iteration no. 1 Xi = -0.7 Xi+1 = -0.936865127065702 f(Xi) = 0.10957001345428005  
 iteration no. 2 Xi = -0.936865127065702 Xi+1 = -0.957983725754814 f(Xi) = 0.008166820052384114  
 iteration no. 3 Xi = -0.957983725754814 Xi+1 = -0.9645198251847715 f(Xi) = 0.00209000955384771  
 iteration no. 4 Xi = -0.9645198251847715 Xi+1 = -0.964882860432231 f(Xi) = 0.00010878849222468171  
 iteration no. 5 Xi = -0.964882860432231 Xi+1 = -0.964883950289899 f(Xi) = 1.6336122697217528e-06  
 after 6 iterations The root found is: -0.964888

Already found that root.

Checked range: -0.7 - -0.6

iteration no. 0 Xi = -0.7 Xi+1 = -0.6 f(Xi) = 0.10957001345428005  
 iteration no. 1 Xi = -0.6 Xi+1 = -0.9702713299726971 f(Xi) = 0.150110759476284  
 iteration no. 2 Xi = -0.9702713299726971 Xi+1 = -0.966441773456789 f(Xi) = -0.001568754134345414  
 iteration no. 3 Xi = -0.966441773456789 Xi+1 = -0.9648897191350737 f(Xi) = -0.00046562475845089  
 iteration no. 4 Xi = -0.9648897191350737 Xi+1 = -0.964884634303756 f(Xi) = 5.5094735112283005e-06  
 after 5 iterations The root found is: -0.964888

Already found that root.

Checked range: -0.6 - -0.5

iteration no. 0 Xi = -0.6 Xi+1 = -0.5 f(Xi) = 0.150110759476284  
 iteration no. 1 Xi = -0.5 Xi+1 = -1.1713389480613214 f(Xi) = 0.17638426314440303  
 iteration no. 2 Xi = -1.1713389480613214 Xi+1 = -1.0627421512104593 f(Xi) = -0.03403826415202739  
 iteration no. 3 Xi = -1.0627421512104593 Xi+1 = -0.84074763401294336 f(Xi) = -0.02258298750852114  
 iteration no. 4 Xi = -0.84074763401294336 Xi+1 = -0.9882055743408006 f(Xi) = 0.02434973658332698  
 iteration no. 5 Xi = -0.9882055743408006 Xi+1 = -0.96595583881631015 f(Xi) = -0.006520309939594807  
 iteration no. 6 Xi = -0.96595583881631015 Xi+1 = -0.9646313804490863 f(Xi) = -0.0013631431907208858  
 iteration no. 7 Xi = -0.9646313804490863 Xi+1 = -0.96488710364586033 f(Xi) = 7.58432525078806e-05  
 iteration no. 8 Xi = -0.96488710364586033 Xi+1 = -0.9648834010085247 f(Xi) = -7.8565350552171505e-07  
 after 9 iterations The root found is: -0.964888

Already found that root.

Checked range: -0.5 - -0.4

iteration no. 0 Xi = -0.5 Xi+1 = -0.4 f(Xi) = 0.17638426314440303  
 iteration no. 1 Xi = -0.4 Xi+1 = -3.086710080846379 f(Xi) = 0.18342074751964313  
 iteration no. 2 Xi = -3.086710080846379 Xi+1 = -2.9977119416825664 f(Xi) = -0.0066355457946347584  
 iteration no. 3 Xi = -2.9977119416825664 Xi+1 = -3.082166858355446 f(Xi) = -0.00886820862662802999  
 iteration no. 4 Xi = -3.082166858355446 Xi+1 = -3.0289035621176024 f(Xi) = 8.88780476476143e-05  
 iteration no. 5 Xi = -3.0289035621176024 Xi+1 = -3.02980405864301467 f(Xi) = -3.9410138770493932e-06  
 iteration no. 6 Xi = -3.02980405864301467 Xi+1 = -3.0299396409821145 f(Xi) = 2.158916097073172e-09  
 after 7 iterations The root found is: -0.302984

root out of range.

Checked range: -0.4 - -0.3

iteration no. 0 Xi = -0.4 Xi+1 = -0.3 f(Xi) = 0.18342074751964313  
 iteration no. 1 Xi = -0.3 Xi+1 = 1.259890426955741 f(Xi) = 0.17237057549979246  
 iteration no. 2 Xi = 1.259890426955741 Xi+1 = -0.18229880685600994 f(Xi) = -2.1120515567552602  
 iteration no. 3 Xi = -0.18229880685600994 Xi+1 = -0.08843398686816428 f(Xi) = -0.147032507810453802  
 iteration no. 4 Xi = -0.08843398686816428 Xi+1 = 0.744793247513243 f(Xi) = 0.15214596922397962  
 iteration no. 5 Xi = 0.744793247513243 Xi+1 = -0.0208784093737032 f(Xi) = -1.4977378213326251  
 iteration no. 6 Xi = -0.0208784093737032 Xi+1 = 0.04246250452246466 f(Xi) = 0.1349989916686012  
 iteration no. 7 Xi = 0.04246250452246466 Xi+1 = -0.4166446189976396 f(Xi) = 0.15688581739096645  
 iteration no. 8 Xi = -0.4166446189976396 Xi+1 = 2.7642796520992665 f(Xi) = 0.183614522766287  
 iteration no. 9 Xi = 2.7642796520992665 Xi+1 = -0.41774987424271 f(Xi) = 9.200408517677402  
 iteration no. 10 Xi = -0.41774987424271 Xi+1 = -0.42438471134369387 f(Xi) = 0.18361214524701794  
 iteration no. 11 Xi = -0.4238471134369387 Xi+1 = -15.585734785642814 f(Xi) = 0.18353833672366093  
 after 12 iterations The root found is: -15.585735

root out of range.

Checked range: -0.3 - -0.2

iteration no. 0 Xi = -0.3 Xi+1 = -0.2 f(Xi) = 0.17237057549979246  
 iteration no. 1 Xi = -0.2 Xi+1 = 0.50846697666705496 f(Xi) = 0.1509479665343485  
 iteration no. 2 Xi = 0.50846697666705496 Xi+1 = -0.2908861896661224 f(Xi) = 1.331586186836359  
 iteration no. 3 Xi = -0.2908861896661224 Xi+1 = -0.4086641613092596 f(Xi) = 0.1052949616861608  
 iteration no. 4 Xi = -0.4086641613092596 Xi+1 = 1.2368596464126482 f(Xi) = 0.18356485437994904  
 iteration no. 5 Xi = 1.2368596464126482 Xi+1 = -0.34278135722368336 f(Xi) = -4.45646419334317  
 iteration no. 6 Xi = -0.34278135722368336 Xi+1 = -0.28887482435283257 f(Xi) = 0.1778387463874707  
 iteration no. 7 Xi = -0.28887482435283257 Xi+1 = 0.736152708350465 f(Xi) = 0.1687326832944552  
 iteration no. 8 Xi = 0.736152708350465 Xi+1 = -0.16540985161594896 f(Xi) = -1.317471470845851  
 iteration no. 9 Xi = -0.16540985161594896 Xi+1 = -0.07686917283212914 f(Xi) = 0.143475548128219e-05  
 iteration no. 10 Xi = -0.07686917283212914 Xi+1 = 0.89826520800574 f(Xi) = 0.1315374893604651  
 iteration no. 11 Xi = 0.89826520800574 Xi+1 = -0.147529874495841125 f(Xi) = -0.05690307382097165  
 iteration no. 12 Xi = -0.147529874495841125 Xi+1 = -0.0711272235733775 f(Xi) = 0.13137285387818642  
 iteration no. 13 Xi = -0.0711272235733775 Xi+1 = 0.7371285362366842 f(Xi) = 0.15805872363576562  
 iteration no. 14 Xi = 0.7371285362366842 Xi+1 = -0.12900302761219332 f(Xi) = -1.33807681261627  
 iteration no. 15 Xi = -0.12900302761219332 Xi+1 = -0.048640685762712445 f(Xi) = 0.13684098256088558  
 iteration no. 16 Xi = -0.048640685762712445 Xi+1 = 0.2052836195146926 f(Xi) = 0.13180078995294864  
 iteration no. 17 Xi = 0.2052836195146926 Xi+1 = -0.059872368056640826 f(Xi) = 24.792004920614954  
 iteration no. 18 Xi = -0.059872368056640826 Xi+1 = -0.0711272235733775 f(Xi) = 0.13137285387818642  
 iteration no. 19 Xi = -0.0711272235733775 Xi+1 = 243.38206386815853 f(Xi) = 0.109564686608829e+211  
 after 20 iterations The root found is: -0.071127

root out of range.

Checked range: 0.3 - 0.4

iteration no. 0 Xi = 0.3 Xi+1 = 0.4 f(Xi) = 0.4553665576726005  
 iteration no. 1 Xi = 0.4 Xi+1 = 0.137120857605839 f(Xi) = 0.14015907446306771  
 iteration no. 2 Xi = 0.137120857605839 Xi+1 = -0.05690307382097165 f(Xi) = 0.24545121497601135  
 iteration no. 3 Xi = -0.05690307382097165 Xi+1 = -0.1098789338163596 f(Xi) = 0.1649167909195106  
 iteration no. 4 Xi = -0.1098789338163596 Xi+1 = -0.0349343383100905 f(Xi) = 0.1341896131542682  
 iteration no. 5 Xi = -0.0349343383100905 Xi+1 = -0.12406819121311476 f(Xi) = 0.084198751357686  
 iteration no. 6 Xi = -0.12406819121311476 Xi+1 = -0.1062147210754833 f(Xi) = -0.03597823166944556  
 iteration no. 7 Xi = -0.1062147210754833 Xi+1 = -0.16862147210754833 f(Xi) = -0.02348773207791236  
 iteration no. 8 Xi = -0.16862147210754833 Xi+1 = -0.7337116074321586 f(Xi) = 0.09420121590113725  
 iteration no. 9 Xi = -0.7337116074321586 Xi+1 = -0.0014563750594886 f(Xi) = -0.079569953084731 f(Xi) = -0.089910296154051818  
 iteration no. 10 Xi = -0.0014563750594886 Xi+1 = -0.9638800275362342 f(Xi) = -0.00318840706210145  
 iteration no. 11 Xi = -0.9638800275362342 Xi+1 = -0.94691354452025 f(Xi) = 0.00029778208989261084  
 iteration no. 12 Xi = -0.94691354452025 Xi+1 = -0.94888454948647 f(Xi) = -7.415086515263924e-08  
 after 13 iterations The root found is: -0.964888

root out of range.

Checked range: -0.2 - -0.1

iteration no. 0 Xi = -0.2 Xi+1 = -0.1 f(Xi) = 0.1509476965343485  
 iteration no. 1 Xi = -0.1 Xi+1 = 0.6462734779428473 f(Xi) = 0.13311094522640127  
 iteration no. 2 Xi = 0.6462734779428473 Xi+1 = -0.451575824193588593 f(Xi) = 0.41551276614625265  
 iteration no. 3 Xi = -0.451575824193588593 Xi+1 = -1.3097881086342741 f(Xi) = -1.1740082623689892 f(Xi) = -0.034265100451359685  
 iteration no. 4 Xi = -1.3097881086342741 Xi+1 = -1.1740082623689892 f(Xi) = -0.034265100451359685  
 iteration no. 5 Xi = -1.1740082623689892 Xi+1 = 46.779433819922815 f(Xi) = -0.03416835298996753  
 iteration no. 6 Xi = 46.779433819922815 Xi+1 = -1.1740082623689892 f(Xi) = 2.1429851000073e+40  
 after 7 iterations The root found is: -1.174008

root out of range.

Checked range: -0.1 - 0.0

iteration no. 0 Xi = -0.1 Xi+1 = 0.0 f(Xi) = 0.13311094522640127  
 iteration no. 1 Xi = 0.0 Xi+1 = -2.117809512762132 f(Xi) = 0.13970774909946293  
 iteration no. 2 Xi = -2.117809512762132 Xi+1 = -2.062376814356598 f(Xi) = -0.0083904039999906939  
 iteration no. 3 Xi = -2.062376814356598 Xi+1 = -2.2144335421067214 f(Xi) = -0.0062302066570294416  
 iteration no. 4 Xi = -2.2144335421067214 Xi+1 = -2.20636218151522 f(Xi) = 0.000341327861506477  
 iteration no. 5 Xi = -2.20636218151522 Xi+1 = -2.206428512056025 f(Xi) = -2.8515220608409319e-06  
 iteration no. 6 Xi = -2.206428512056025 Xi+1 = -2.2064280259283238 f(Xi) = 2.10527188383737e-08  
 after 7 iterations The root found is: -2.206428

root out of range.

Checked range: 0.0 - 0.1

iteration no. 0 Xi = 0.0 Xi+1 = 0.1 f(Xi) = 0.13970774909946293  
 iteration no. 1 Xi = 0.1 Xi+1 = -0.2283593327907214 f(Xi) = 0.200886656840530562  
 iteration no. 2 Xi = -0.2283593327907214 Xi+1 = -1.416207185577614 f(Xi) = 0.15738138435835006  
 iteration no. 3 Xi = -1.416207185577614 Xi+1 = -1.2295745810122607 f(Xi) = -0.02933664612846618  
 iteration no. 4 Xi = -1.2295745810122607 Xi+1 = -2.2934923874613315 f(Xi) = -0.03557791367847386  
 iteration no. 5 Xi = -2.2934923874613315 Xi+1 = -2.205683217213113 f(Xi) = 0.0032249773509420145  
 iteration no. 6 Xi = -2.205683217213113 Xi+1 = -2.2065565830284022 f(Xi) = -5.94830046220199e-05  
 iteration no. 7 Xi = -2.2065565830284022 Xi+1 = -2.206428284759568 f(Xi) = 0.98523682248220706-06  
 iteration no. 8 Xi = -2.206428284759568 Xi+1 = -2.2064280205812086 f(Xi) = 1.1209778579564496e-08  
 after 9 iterations The root found is: -2.206428

root out of range.

Checked range: 0.0 - 0.2

iteration no. 0 Xi = 0.0 Xi+1 = 0.2 f(Xi) = 0.13970774909946293  
 iteration no. 1 Xi = 0.2 Xi+1 = -0.2283593327907214 f(Xi) = 0.200886656840530562  
 iteration no. 2 Xi = -0.2283593327907214 Xi+1 = -1.416207185577614 f(Xi) = 0.15738138435835006  
 iteration no. 3 Xi = -1.416207185577614 Xi+1 = -1.2295745810122607 f(Xi) = -0.02933664612846618  
 iteration no. 4 Xi = -1.2295745810122607 Xi+1 = -2.2934923874613315 f(Xi) = -0.03557791367847386  
 iteration no. 5 Xi = -2.2934923874613315 Xi+1 = -2.205683217213113 f(Xi) = 0.0032249773509420145  
 iteration no. 6 Xi = -2.205683217213113 Xi+1 = -2.2065565830284022 f(Xi) = -5.94830046220199e-05  
 iteration no. 7 Xi = -2.2065565830284022 Xi+1 = -2.206428284759568 f(Xi) = 0.98523682248220706-06  
 iteration no. 8 Xi = -2.206428284759568 Xi+1 = -2.2064280205812086 f(Xi) = 1.1209778579564496e-08  
 after 9 iterations The root found is: -2.206428

root out of range.

Checked range: 0.1 - 0.2

iteration no. 0 Xi = 0.1 Xi+1 = 0.2 f(Xi) = 0.13970774909946293  
 iteration no. 1 Xi = 0.2 Xi+1 = -0.2283593327907214 f(Xi) = 0.200886656840530562  
 iteration no. 2 Xi = -0.2283593327907214 Xi+1 = -1.416207185577614 f(Xi) = 0.15738138435835006  
 iteration no. 3 Xi = -1.416207185577614 Xi+1 = -1.2295745810122607 f(Xi) = -0.02933664612846618  
 iteration no. 4 Xi = -1.2295745810122607 Xi+1 = -2.2934923874613315 f(Xi) = -0.03557791367847386  
 iteration no. 5 Xi = -2.2934923874613315 Xi+1 = -2.205683217213113 f(Xi) = 0.0032249773509420145  
 iteration no. 6 Xi = -2.205683217213113 Xi+1 = -2.2065565830284022 f(Xi) = -5.94830046220199e-05  
 iteration no. 7 Xi = -2.2065565830284022 Xi+1 = -2.206428284759568 f(Xi) = 0.98523682248220706-06  
 iteration no. 8 Xi = -2.206428284759568 Xi+1 = -2.2064280205812086 f(Xi) = 1.1209778579564496e-08  
 after 9 iterations The root found is: -2.206428

root out of range.

Checked range: 0.2 - 0.3

iteration no. 0 Xi = 0.2 Xi+1 = 0.3 f(Xi) = 0.35707601331539573  
 iteration no. 1 Xi = 0.3 Xi+1 = 0.0761402271754356 f(Xi) = 0.6453665576726005  
 iteration no. 2 Xi = 0.6453665576726005 Xi+1 = -0.09988223355396831 f(Xi) = 0.17931139781740174  
 iteration no. 3 Xi = -0.09988223355396831 Xi+1 = -0.2940855310453917 f(Xi) = 0.13719093222919364  
 iteration no. 4 Xi = -0.2940855310453917 Xi+1 = 0.141308033269123 f(Xi) = 0.17059073223917364  
 iteration no. 5 Xi = 0.141308033269123 f(Xi) = -0.156650745833662 f(Xi) = -0.65357380164037746  
 iteration no. 6 Xi = -0.156650745833662 Xi+1 = -0.05426858184066634 f(Xi) = 0.14177300164037746  
 iteration no. 7 Xi = -0.05426858184066634 Xi+1 = 0.1265557822158566 f(Xi) = 0.13152894849274876  
 iteration no. 8 Xi = 0.1265557822158566 Xi+1 = 0.060722872249547 f(Xi) = -1.3778924617515585  
 iteration no. 9 Xi = 0.060722872249547 Xi+1 = 0.191627636380936 f(Xi) = 0.1679558994086976  
 iteration no. 10 Xi = 0.191627636380936 f(Xi) = -0.06760115136017973 f(Xi) = 0.3392896349947806  
 iteration no. 11 Xi = -0.06760115136017973 Xi+1 = -0.23131389770851 f(Xi) = 0.13133265102866434  
 iteration no. 12 Xi = -0.23131389770851 Xi+1 = 0.737131389770851 f(Xi) = 0.1580587236576562  
 iteration no. 13 Xi = 0.7371285362366842 Xi+1 = -0.12900302761219332 f(Xi) = -1.33807681261627  
 iteration no. 14 Xi = -0.12900302761219332 Xi+1 = -0.048640685762712445 f(Xi) = 0.13684098256088558  
 iteration no. 15 Xi = -0.048640685762712445 Xi+1 = 0.2052836195146926 f(Xi) = 0.13180078995294864  
 iteration no. 16 Xi = 0.2052836195146926 Xi+1 = -0.059872368056640826 f(Xi) = 24.792004920614954  
 iteration no. 17 Xi = -0.059872368056640826 Xi+1 = -0.059872368056640826 f(Xi) = 0.13137285387818642  
 iteration no. 18 Xi = -0.059872368056640826 f(Xi) = 0.23.38206386815853 f(Xi) = 0.1313789753317

Checked range: 0.4 - 0.5  
iteration no. 0 Xi = 0.4 Xi+1 = 0.5 f(Xi) = 1.0415907446386771  
iteration no. 1 Xi = 0.5 Xi+1 = 0.5 0.370895831505225 f(Xi) = 1.3286011778102327  
iteration no. 2 Xi = 0.0370895831505225 Xi+1 = -0.023635321944274124 f(Xi) = 0.15407986572893772  
iteration no. 3 Xi = -0.023635321944274124 Xi+1 = -0.44154265615133376 f(Xi) = 0.1345246872361941  
iteration no. 4 Xi = -0.44154265615133376 Xi+1 = 1.138223856975143 f(Xi) = 0.182919753829585  
iteration no. 5 Xi = 1.138223856975143 f(Xi) = -0.255783613031395 f(Xi) = -1.3719694330095678  
iteration no. 6 Xi = -0.255783613031395 f(Xi) = -0.10729488950811166 f(Xi) = 0.1634752852245224  
iteration no. 7 Xi = -0.10729488950811166 f(Xi) = 0.564193854272404 f(Xi) = 0.13388480316780163  
iteration no. 8 Xi = 0.564193854272404 f(Xi) = -0.19023565962997972 f(Xi) = 1.2178165263500384  
iteration no. 9 Xi = -0.19023565962997972 f(Xi) = -0.2952231795395216 f(Xi) = 0.1407706702092211  
iteration no. 10 Xi = 0.1407706702092211 f(Xi) = 0.4978360162870845 f(Xi) = 0.1714961642156169  
iteration no. 11 Xi = 0.4978360162870845 f(Xi) = -0.412912446218459 f(Xi) = 0.3259719885627984  
iteration no. 12 Xi = 0.3259719885627984 f(Xi) = -0.5591758823588994 f(Xi) = 0.1836195257807891  
iteration no. 13 Xi = -0.5591758823588994 f(Xi) = -1.71370624739786 f(Xi) = 0.162986295956656802  
iteration no. 14 Xi = -1.71370624739786 f(Xi) = -1.610112230742215 f(Xi) = -0.0159541942516686  
iteration no. 15 Xi = -1.610112230742215 f(Xi) = -2.1612294361442475 f(Xi) = -0.016392985774034  
iteration no. 16 Xi = -2.1612294361442475 f(Xi) = -2.2375426767881 f(Xi) = -0.0020040296563824115  
iteration no. 17 Xi = -2.2375426767881 f(Xi) = -2.2064195224049662 f(Xi) = 0.0007373233987472551  
iteration no. 18 Xi = -2.2064195224049662 f(Xi) = -2.086419486222924 f(Xi) = 2.1089159100839866-05  
iteration no. 19 Xi = -2.086419486222924 f(Xi) = -2.20642892894768534 f(Xi) = -3.7317932531102856  
after 20 iterations The root found is: -2.206428

root out of range.

Checked range: 0.5 - 0.6

iteration no. 0 Xi = 0.5 Xi+1 = 0.6 f(Xi) = 1.3286011778102327  
iteration no. 1 Xi = 0.6 Xi+1 = 0.8738201931210734 f(Xi) = 0.971893508978189  
iteration no. 2 Xi = 0.8738201931210734 f(Xi) = 0.6852594473936893 f(Xi) = -2.152334633759651  
iteration no. 3 Xi = 0.6852594473936893 f(Xi) = 0.6592166032637348 f(Xi) = -0.261190646622653  
iteration no. 4 Xi = 0.6592166032637348 f(Xi) = 0.6708243487875 f(Xi) = 0.21003183610675047  
iteration no. 5 Xi = 0.6708243487875 f(Xi) = 0.6713355191875632 f(Xi) = 0.00885918801819855  
iteration no. 6 Xi = 0.6713355191875632 f(Xi) = 0.67131635975204712 f(Xi) = -0.000342741559994657  
after 7 iterations The root found is: 0.671316

root out of range.

Checked range: 0.6 - 0.7

iteration no. 0 Xi = 0.6 Xi+1 = 0.7 f(Xi) = 0.971893508978109  
iteration no. 1 Xi = 0.7 Xi+1 = 0.6365565603313662 f(Xi) = -0.55564687451692  
iteration no. 2 Xi = 0.6365565603313662 f(Xi) = 0.6707559735644344 f(Xi) = 0.13499048087208683  
iteration no. 3 Xi = 0.6707559735644344 f(Xi) = 0.6713299286848674 f(Xi) = 0.01089779685192415  
iteration no. 4 Xi = 0.6713298204868474 f(Xi) = 0.671316640311433 f(Xi) = -0.0002415185563878484  
after 5 iterations The root found is: 0.671316

Checked range: 0.7 - 0.8

iteration no. 0 Xi = 0.7 Xi+1 = 0.8 f(Xi) = -0.55564687451692  
iteration no. 1 Xi = 0.8 Xi+1 = 0.67026900368688 f(Xi) = -2.4245576713282246  
iteration no. 2 Xi = 0.67026900368688 f(Xi) = 0.6712685638520197 f(Xi) = 0.01882593384922142  
iteration no. 3 Xi = 0.6712685638520197 f(Xi) = 0.6713165747994686 f(Xi) = 0.0008638205274617789  
iteration no. 4 Xi = 0.6713165747994686 f(Xi) = 0.6713164253844833 f(Xi) = -2.693469220201761e-06  
after 3 iterations The root found is: 0.671316

Already found that root.

Checked range: 0.8 - 0.9

iteration no. 0 Xi = 0.8 Xi+1 = 0.9 f(Xi) = -2.4245576713282246  
iteration no. 1 Xi = 0.9 Xi+1 = 1.04351203376148 f(Xi) = -1.4288953075934285  
iteration no. 2 Xi = 1.04351203376148 f(Xi) = 0.9378689391586831 f(Xi) = 3.987337785978481  
iteration no. 3 Xi = 0.9378689391586831 f(Xi) = 0.933564982868577 f(Xi) = 0.1557998628927655  
iteration no. 4 Xi = 0.933564982868577 f(Xi) = 0.9345850850224666 f(Xi) = -0.04851494818857998  
iteration no. 5 Xi = 0.9345850850224666 f(Xi) = 0.9345939927847926 f(Xi) = -0.0004195087593598653  
after 6 iterations The root found is: 0.934594

root out of range.

Checked range: 0.9 - 1.0

iteration no. 0 Xi = 0.9 Xi+1 = 1.0 f(Xi) = -1.4288953075934285  
iteration no. 1 Xi = 1.0 Xi+1 = 0.9314891856931461 f(Xi) = 0.108883156183984  
iteration no. 2 Xi = 0.9314891856931461 f(Xi) = 0.9345525154797371 f(Xi) = -0.1455120424735054  
iteration no. 3 Xi = 0.9345525154797371 f(Xi) = 0.934542636798295 f(Xi) = -0.0019555945813322114  
iteration no. 4 Xi = 0.934542636798295 f(Xi) = 0.934593877423632 f(Xi) = 1.7313453408200425e-05  
after 5 iterations The root found is: 0.934594

Checked range: 1.0 - 1.1

iteration no. 0 Xi = 1.0 Xi+1 = 1.1 f(Xi) = 3.108838156183984  
iteration no. 1 Xi = 1.1 Xi+1 = 1.2528791978493717 f(Xi) = 1.8794613351923537  
iteration no. 2 Xi = 1.2528791978493717 f(Xi) = 1.1595642271308628 f(Xi) = -2.9444604657998045  
iteration no. 3 Xi = 1.1595642271308628 f(Xi) = 1.0881161969248065 f(Xi) = -3.273374262643385  
iteration no. 4 Xi = 1.0881161969248065 f(Xi) = 1.30996867254929494 f(Xi) = 16.935653236851986  
iteration no. 5 Xi = 1.30996867254929494 f(Xi) = 0.9940270175988511 f(Xi) = 4.890662182191044  
iteration no. 6 Xi = 0.9940270175988511 f(Xi) = 0.5450817916498985 f(Xi) = 2.870573992347  
iteration no. 7 Xi = 0.5450817916498985 f(Xi) = 0.17898073872718644 f(Xi) = 1.2893982233744687  
iteration no. 8 Xi = 0.17898073872718644 f(Xi) = 0.0610305177134247 f(Xi) = 0.35141917013134395  
iteration no. 9 Xi = 0.0610305177134247 f(Xi) = -0.0747996549538178 f(Xi) = 0.16816381325761426  
iteration no. 10 Xi = -0.0747996549538178 f(Xi) = -0.5614357193672064 f(Xi) = 0.1314683394396481  
iteration no. 11 Xi = -0.5614357193672064 f(Xi) = 1.9986483675829833 f(Xi) = 0.162323843556823  
iteration no. 12 Xi = 1.9986483675829833 f(Xi) = -0.5461928652018569 f(Xi) = -27.89931778780866  
iteration no. 13 Xi = -0.5461928652018569 f(Xi) = -0.5350854985850217 f(Xi) = 0.16646408026156423  
iteration no. 14 Xi = -0.5350854985850217 f(Xi) = -1.228901188644643 f(Xi) = 0.1702543794135701  
iteration no. 15 Xi = -1.228901188644643 f(Xi) = -1.108223265724263 f(Xi) = -0.03557427085410377  
iteration no. 16 Xi = -1.108223265724263 f(Xi) = -0.5799865931067929 f(Xi) = -0.028995951554001058  
iteration no. 17 Xi = -0.5799865931067929 f(Xi) = -1.0285464372788766 f(Xi) = 0.15678293947953316  
iteration no. 18 Xi = -1.0285464372788766 f(Xi) = -0.98526586346917693 f(Xi) = -0.015494117616585268  
iteration no. 19 Xi = -0.98526586346917693 f(Xi) = -0.9614419228207995 f(Xi) = -0.00583567942798647  
iteration no. 20 Xi = -0.9614419228207995 f(Xi) = -0.9650523889897512 f(Xi) = 0.00102411713106559989  
iteration no. 21 Xi = -0.9650523889897512 f(Xi) = -0.964889621945465 f(Xi) = -4.83430807091003e-05  
iteration no. 22 Xi = -0.964889621945465 f(Xi) = -0.9648883998617748 f(Xi) = -3.62481462198667e-07  
after 23 iterations The root found is: -0.964888

Already found that root.

Checked range: 1.1 - 1.2

iteration no. 0 Xi = 1.1 Xi+1 = 1.2 f(Xi) = 1.8794613351923537  
iteration no. 1 Xi = 1.2 Xi+1 = 1.1254590586183568 f(Xi) = -5.502827866336455  
iteration no. 2 Xi = 1.1254590586183568 f(Xi) = 1.1225986588630736 f(Xi) = -0.20353867901291818  
iteration no. 3 Xi = 1.1225986588630736 f(Xi) = 1.1231802764236875 f(Xi) = 0.051902026417576226  
iteration no. 4 Xi = 1.1231802764236875 f(Xi) = 1.123183628419643 f(Xi) = 0.0002979467432047106  
after 5 iterations The root found is: 1.123184

Checked range: 1.2 - 1.3

iteration no. 0 Xi = 1.2 Xi+1 = 1.3 f(Xi) = -5.502827866336455  
iteration no. 1 Xi = 1.3 Xi+1 = 1.26058148484639 f(Xi) = 3.588521415648707  
iteration no. 2 Xi = 1.26058148484639 f(Xi) = 1.27482255840780743 f(Xi) = -0.20524248681983  
iteration no. 3 Xi = 1.27482255840780743 f(Xi) = 1.2754802764054948 f(Xi) = -0.087697552042975365  
iteration no. 4 Xi = 1.2754802764054948 f(Xi) = 1.2754316131358379 f(Xi) = 0.005185289315689485  
after 5 iterations The root found is: 1.275432

Checked range: 1.3 - 1.4

iteration no. 0 Xi = 1.3 Xi+1 = 1.4 f(Xi) = 3.5805214115648707  
iteration no. 1 Xi = 1.4 Xi+1 = 1.4455856240543372 f(Xi) = 1.1211292601608918  
iteration no. 2 Xi = 1.4455856240543372 Xi+1 = 1.4056767712628346 f(Xi) = -7.8817659779487  
iteration no. 3 Xi = 1.4056767712628346 Xi+1 = 1.4052560244474295 f(Xi) = -0.0822281393149035  
iteration no. 4 Xi = 1.4052560244474295 Xi+1 = 1.405295698731947 f(Xi) = 0.008411372859998906  
after 5 iterations The root found is: 1.405295

root out of range.

Checked range: 1.4 - 1.5

iteration no. 0 Xi = 1.4 Xi+1 = 1.5 f(Xi) = 1.1211292601608918  
iteration no. 1 Xi = 1.5 Xi+1 = 1.4172221586291531 f(Xi) = -5.388677578240142  
iteration no. 2 Xi = 1.4172221586291531 Xi+1 = 1.33988682666965385 f(Xi) = -2.6030766947170805  
iteration no. 3 Xi = 1.33988682666965385 Xi+1 = 1.396836346127138 f(Xi) = 7.27428842455648  
iteration no. 4 Xi = 1.396836346127138 Xi+1 = 1.4151308161361735 f(Xi) = 1.7682001528112075  
iteration no. 5 Xi = 1.4151308161361735 Xi+1 = 1.4050996051381919 f(Xi) = -2.1465125874484277  
iteration no. 6 Xi = 1.4050996051381919 Xi+1 = 1.4052932842116925 f(Xi) = 0.0420594212766831  
iteration no. 7 Xi = 1.4052932842116925 Xi+1 = 1.4052951082069194 f(Xi) = 0.0005864121239137062  
after 8 iterations The root found is: 1.405295

Checked range: 1.5 - 1.6

iteration no. 0 Xi = 1.5 Xi+1 = 1.6 f(Xi) = -5.388677578240142  
iteration no. 1 Xi = 1.6 Xi+1 = 1.5400956015744827 f(Xi) = 8.050895259269218  
iteration no. 2 Xi = 1.5400956015744827 Xi+1 = 1.3482772984584497 f(Xi) = 6.134961438680677  
iteration no. 3 Xi = 1.3482772984584497 Xi+1 = 2.5129542874611386 f(Xi) = 7.3445980246977227  
iteration no. 4 Xi = 2.5129542874611386 Xi+1 = 1.1596894593280747 f(Xi) = 52.70316317380482  
iteration no. 5 Xi = 1.1596894593280747 Xi+1 = 1.2390616120351183 f(Xi) = -3.2837644773933046  
iteration no. 6 Xi = 1.2390616120351183 Xi+1 = 1.2398616120351183 f(Xi) = -4.284243577270245  
iteration no. 7 Xi = 1.2398616120351183 Xi+1 = 0.8991748164268013 f(Xi) = -4.284243577270245  
iteration no. 8 Xi = 0.8991748164268013 Xi+1 = 0.7240406405086464 f(Xi) = -1.456867797742969  
iteration no. 9 Xi = 0.7240406405086464 Xi+1 = 0.25528719791362275 f(Xi) = -1.060607124311429  
iteration no. 10 Xi = 0.25528719791362275 Xi+1 = 0.49528345122998335 f(Xi) = 0.499085511599185  
iteration no. 11 Xi = 0.49528345122998335 Xi+1 = 0.40528345122998335 f(Xi) = 0.1224736688478442  
iteration no. 12 Xi = 0.40528345122998335 Xi+1 = -0.13444190603408026 f(Xi) = 0.15884976487141897  
iteration no. 13 Xi = -0.13444190603408026 Xi+1 = -1.3104040705582753 f(Xi) = 0.13771511309844658  
iteration no. 14 Xi = -1.3104040705582753 Xi+1 = -1.0762216673485083 f(Xi) = -0.03424412872667759  
iteration no. 15 Xi = -1.0762216673485083 Xi+1 = -0.46700774153218716 f(Xi) = -0.024735701804428183  
iteration no. 16 Xi = -0.46700774153218716 Xi+1 = -1.00294420230977792 f(Xi) = 0.18891188707071942  
iteration no. 17 Xi = -1.00294420230977792 Xi+1 = -0.9741379609738959 f(Xi) = -0.010276239276819891  
iteration no. 18 Xi = -0.9741379609738959 Xi+1 = -0.9640141701937348 f(Xi) = -0.002672345507840508  
iteration no. 19 Xi = -0.9640141701937348 Xi+1 = -0.9649065312131578 f(Xi) = 0.000258323685861709  
iteration no. 20 Xi = -0.9649065312131578 Xi+1 = -0.9648884342097137 f(Xi) = -5.347222975456557e-06  
after 21 iterations The root found is: -0.964888

Already found that root.

## הרצאה של השיטות אינטגרציה על הפקנץיה הנדרשת

```
print(bcolors.OKGREEN, "\nNumerical Integration", bcolors.ENDC)
print(bcolors.BOLD, "Division into sections n =", n, bcolors.ENDC)
print(bcolors.OKBLUE, "Numerical Integration of definite integral in range [0,1] ∫= sin(2X³+5X²-6) / 2e^-2X\n", bcolors.ENDC)
print(bcolors.OKGREEN, "\n\tSimpson's Rule", bcolors.ENDC)
res = SimpsonRule(func, n, 0, 1)
if res[1]:
    print(bcolors.OKBLUE, "I = ", printFinalResult(round(res[0], 6)), bcolors.ENDC)
else:
    print(bcolors.FAIL, "n must be even !", bcolors.ENDC)
print(bcolors.OKGREEN, "\n\tRomberg's method", bcolors.ENDC)
print(bcolors.OKBLUE, "I = ", printFinalResult(round(RombergsMethod(func, n, 0, 1)[n - 1][n - 1], 6)), bcolors.ENDC)

MainFunction()
```

פלט: (כולל חישובים)

чисוב באמצעות שיטת סימפסון תוצאה סופית:  $I = 0.14651900000132311$

```
| Numerical Integration
| Division into sections n = 18
| Numerical Integration of definite integral in range [0,1] ∫= sin(2X³+5X²-6) / 2e^-2X

| Simpson's Rule
| h = 0.0555555555555555
| h/3 ( 0.13970774909946293 + 2 * 0.13970774909946293 + 0.16456967070326137 )
| h/3 ( 0.16456967070326137 + 4 * 0.16456967070326137 + 2 * 0.13970774909946293 + 0.21273896540784673 )
| h/3 ( 0.21273896540784673 + 4 * 0.16456967070326137 + 2 * 0.21273896540784673 + 0.29174056353327465 )
| h/3 ( 0.29174056353327465 + 4 * 0.29174056353327465 + 2 * 0.21273896540784673 + 0.4089574919034477 )
| h/3 ( 0.4089574919034477 + 4 * 0.29174056353327465 + 2 * 0.4089574919034477 + 0.5692682364696289 )
| h/3 ( 0.5692682364696289 + 4 * 0.5692682364696289 + 2 * 0.4089574919034477 + 0.7705511129438078 )
| h/3 ( 0.7705511129438078 + 4 * 0.5692682364696289 + 2 * 0.7705511129438078 + 0.9964556847314752 )
| h/3 ( 0.9964556847314752 + 4 * 0.9964556847314752 + 2 * 0.7705511129438078 + 1.2068181593027025 )
| h/3 ( 1.2068181593027025 + 4 * 0.9964556847314752 + 2 * 1.2068181593027025 + 1.3286011778102327 )
| h/3 ( 1.3286011778102327 + 4 * 1.3286011778102327 + 2 * 1.2068181593027025 + 1.2548297005724633 )
| h/3 ( 1.2548297005724633 + 4 * 1.3286011778102327 + 2 * 1.2548297005724633 + 0.8649117567406899 )
| h/3 ( 0.8649117567406899 + 4 * 0.8649117567406899 + 2 * 1.2548297005724633 + 0.08266160754507483 )
| h/3 ( 0.08266160754507483 + 4 * 0.8649117567406899 + 2 * 0.08266160754507483 + -1.021924288391885 )
| h/3 ( -1.021924288391885 + 4 * -1.021924288391885 + 2 * 0.08266160754507483 + -2.11893112813204 )
| h/3 ( -2.11893112813204 + 4 * -1.021924288391885 + 2 * -2.11893112813204 + -2.594252115498781 )
| h/3 ( -2.594252115498781 + 4 * -2.594252115498781 + 2 * -2.11893112813204 + -1.777888625958292 )
| h/3 ( -1.777888625958292 + 4 * -2.594252115498781 + 2 * -1.777888625958292 + 0.476773305624748 )
| h/3 ( 0.476773305624748 + 4 * 0.476773305624748 + 2 * -1.777888625958292 + 0.476773305624748 )

I = 0.14651900000132311
```

```
Römbberg's method
R[1][1] = 1.004691
R[2][1] = -0.092584
R[2][2] = -0.165735
R[3][1] = 0.005132
R[3][2] = 0.011646
R[3][3] = 0.014462
R[4][1] = 0.087927
R[4][2] = 0.093447
R[4][3] = 0.094745
R[4][4] = 0.09506
R[5][1] = 0.115787
R[5][2] = 0.117645
R[5][3] = 0.118029
R[5][4] = 0.11812
R[5][5] = 0.118143
R[6][1] = 0.12907
R[6][2] = 0.129956
R[6][3] = 0.130151
R[6][4] = 0.130199
R[6][5] = 0.13021
R[6][6] = 0.130213
R[7][1] = 0.135676
R[7][2] = 0.136116
R[7][3] = 0.136214
R[7][4] = 0.136238
R[7][5] = 0.136244
R[7][6] = 0.136245
R[7][7] = 0.136246
R[8][1] = 0.138977
R[8][2] = 0.139197
R[8][3] = 0.139246
R[8][4] = 0.139258
R[8][5] = 0.139261
R[8][6] = 0.139261
R[8][7] = 0.139262
R[8][8] = 0.139262
R[9][1] = 0.140627
R[9][2] = 0.140737
R[9][3] = 0.140762
R[9][4] = 0.140768
R[9][5] = 0.140769
R[9][6] = 0.140769
R[9][7] = 0.14077
R[9][8] = 0.14077
R[9][9] = 0.14077
R[10][1] = 0.141452
R[10][2] = 0.141507
R[10][3] = 0.141512
R[10][4] = 0.141523
R[10][5] = 0.141523
R[10][6] = 0.141523
R[10][7] = 0.141523
R[10][8] = 0.141524
R[10][9] = 0.141524
R[10][10] = 0.141524
R[11][1] = 0.141865
R[11][2] = 0.141892
R[11][3] = 0.141899
R[11][4] = 0.1419
R[11][5] = 0.1419
R[11][6] = 0.1419
R[11][7] = 0.1419
R[11][8] = 0.1419
R[11][9] = 0.1419
R[11][10] = 0.1419
R[11][11] = 0.1419
R[12][1] = 0.142071
R[12][2] = 0.142085
R[12][3] = 0.142088
R[12][4] = 0.142089
R[12][5] = 0.142089
R[12][6] = 0.142089
R[12][7] = 0.142089
R[12][8] = 0.142089
R[12][9] = 0.142089
R[12][10] = 0.142089
R[12][11] = 0.142089
R[12][12] = 0.142089
R[13][1] = 0.142174
R[13][2] = 0.142181
R[13][3] = 0.142183
R[13][4] = 0.142183
R[13][5] = 0.142183
R[13][6] = 0.142183
R[13][7] = 0.142183
R[13][8] = 0.142183
R[13][9] = 0.142183
R[13][10] = 0.142183
R[14][1] = 0.142226
R[14][2] = 0.142229
R[14][3] = 0.14223
R[14][4] = 0.14223
R[14][5] = 0.14223
R[14][6] = 0.14223
R[14][7] = 0.14223
R[14][8] = 0.14223
R[14][9] = 0.14223
I = 0.14227200000132317
```

השוואה בין השיטות:

 $I = 0.14651900000132311$ : סימפסון: $I = 0.14227200000132317$ : רומברג:

שיטת רומברג נותנת קירוב מדויק יותר

لتוצאה המקורית של האינטגרל

# Numeric Analysis - Final Project

## Finding Equation Roots + Numerical Integration

### Question 12

• שאלה מס' 12

עבור הפונקציה הבאה

$$f(x) = (2xe^{-x} + \ln(2x^2))(2x^4 + 2x^2 - 3x - 5)$$

3. מצאו באמצעות שתי שיטות את כל השורשים האמתיים הנמצאים בקטע  $[0., 1.5]$
4. השתמשו בקירוב סימפסון ובשיטת רומברג למציאת הערך של האינטגרל בקטע  $[0.5, 1]$

GitHub: <https://github.com/Maor-Ar/Numerical-Analysis-Hackathon/blob/main/Q12%20Finding%20Equation%20Roots%20Numerical%20Integration.py>

פתרון

מציאת שורשים ע"י שימוש בשיטת המיתר ובשיטת החציה

הרצה של השיטות על הפונקציה הנדרשת

```
def MainFunction():

    roots = []
    x = sp.symbols('x')
    my_f = (2 * x * sp.exp(-x) + sp.ln(2 * x ** 2)) * (2 * x ** 4 + 2 * x ** 2 - 3 * x - 5)

    my_f_diff = lambda a: sp.diff(my_f, x).subs(x, a)
    checkRange = frange(0, 1.5, 0.1)
    epsilon = 0.00001

    print("\nFinding roots of the equation f(x) = ( 2Xe^-X + ln(2X^2) ) * (2X^4 + 2X^2 - 3X - 5 )\n")
    print("Bisection Method on ( 2Xe^-X + ln(2X^2) ) * (2X^4 + 2X^2 - 3X - 5 ) :\n")
    print(bcolors.OKGREEN, " ~ Odd multiplicity Roots ~~ ", bcolors.ENDC)
    roots += BisectionMethodSections(func, checkRange, epsilon)
    print(bcolors.OKGREEN, "\n ~~ Even multiplicity Roots ~~ ", bcolors.ENDC)
    root = BisectionMethodSections(my_f_diff, checkRange, epsilon)
    if func(root[0]) == 0:
        roots += root
    else:
        print(bcolors.FAIL, " Not the root of the equation ", bcolors.ENDC)
    print("\nThere are ", bcolors.OKBLUE, len(roots), "roots found by Bisection Method", bcolors.ENDC)
    printFinalResult(roots)
    roots.clear()

    print("\nSecant Method on ( 2Xe^-X + ln(2X^2) ) * (2X^4 + 2X^2 - 3X - 5 ) :\n")
    roots += SecantMethodInRangeIterations(func, checkRange, 0.0000001)
    print("\nThere are ", bcolors.OKBLUE, len(roots), "roots found by Secant Method ", bcolors.ENDC)
    printFinalResult(roots)
```

פלט סופי: (ופלט של האיטרציות)

There are 2 roots found by Bisection Method  
0.5191860000014026  
1.290170000014026

There are 2 roots found by Secant Method  
0.5191870000014026  
1.2901730000014026



## שיטות אינטגרציה:

```
Finding area of the equation f(X) = ( 2Xe^-X + ln(2X^2) ) * (2X^4 + 2X^2 - 3X - 5 )

Simpson Rule on ( 2Xe^-X + ln(2X^2) ) * (2X^4 + 2X^2 - 3X - 5 ) :
h = 0.025
h/3 * ( 0.5088720599779571 + + 2 * 0.5088720599779571 + -0.15012038464662125 )
h/3 * ( -0.15012038464662125 + 4 * -0.15012038464662125 + 2 * 0.5088720599779571 + -0.7744738914043297 )
h/3 * ( -0.7744738914043297 + 4 * -0.15012038464662125 + 2 * -0.7744738914043297 + -1.3647622913968367 )
h/3 * ( -1.3647622913968367 + 4 * -1.3647622913968367 + 2 * -0.7744738914043297 + -1.9212708526205036 )
h/3 * ( -1.9212708526205036 + 4 * -1.3647622913968367 + 2 * -1.9212708526205036 + -2.444032749017358 )
h/3 * ( -2.444032749017358 + 4 * -2.444032749017358 + 2 * -1.9212708526205036 + -2.9328580747180015 )
h/3 * ( -2.9328580747180015 + 4 * -2.444032749017358 + 2 * -2.9328580747180015 + -3.3873571336141723 )
h/3 * ( -3.3873571336141723 + 4 * -3.3873571336141723 + 2 * -2.9328580747180015 + -3.8069592861225607 )
h/3 * ( -3.8069592861225607 + 4 * -3.3873571336141723 + 2 * -3.8069592861225607 + -4.1909283139479845 )
h/3 * ( -4.1909283139479845 + 4 * -4.1909283139479845 + 2 * -3.8069592861225607 + -4.53837503071748 )
h/3 * ( -4.53837503071748 + 4 * -4.1909283139479845 + 2 * -4.53837503071748 + -4.848267695327701 )
h/3 * ( -4.848267695327701 + 4 * -4.848267695327701 + 2 * -4.53837503071748 + -5.119440657887542 )
h/3 * ( -5.119440657887542 + 4 * -4.848267695327701 + 2 * -5.119440657887542 + -5.350601572931377 )
h/3 * ( -5.350601572931377 + 4 * -5.350601572931377 + 2 * -5.119440657887542 + -5.540337442510842 )
h/3 * ( -5.540337442510842 + 4 * -5.350601572931377 + 2 * -5.540337442510842 + -5.687119696744635 )
h/3 * ( -5.687119696744635 + 4 * -5.687119696744635 + 2 * -5.540337442510842 + -5.78930847704715 )
h/3 * ( -5.78930847704715 + 4 * -5.687119696744635 + 2 * -5.78930847704715 + -5.845156254404423 )
h/3 * ( -5.845156254404423 + 4 * -5.845156254404423 + 2 * -5.78930847704715 + -5.852810889407815 )
h/3 * ( -5.852810889407815 + 4 * -5.845156254404423 + 2 * -5.852810889407815 + -5.810318220584752 )
h/3 * ( -5.810318220584752 + 4 * -5.810318220584752 + 2 * -5.852810889407815 + -5.810318220584752 )
I = -1.9421280000014026
```

תוצאה סימפוני:

$$I = -1.9421280000014026$$

תוצאה רומברג:

$$I = -1.9506080000014114$$

שימוש בשיטת רומברג נותן קירוב טוב יותר

```
Rumberg Rule on ( 2Xe^-X + ln(2X^2) ) * (2X^4 + 2X^2 - 3X - 5 ) :

R[1][1] = -1.670356
R[2][1] = -1.812172
R[2][2] = -1.821627
R[3][1] = -1.881509
R[3][2] = -1.886131
R[3][3] = -1.887155
R[4][1] = -1.916067
R[4][2] = -1.918371
R[4][3] = -1.918883
R[4][4] = -1.919007
R[5][1] = -1.933339
R[5][2] = -1.93449
R[5][3] = -1.934746
R[5][4] = -1.934808
R[5][5] = -1.934824
R[6][1] = -1.941974
R[6][2] = -1.94255
R[6][3] = -1.942678
R[6][4] = -1.942709
R[6][5] = -1.942717
R[6][6] = -1.942718
R[7][1] = -1.946292
R[7][2] = -1.94658
R[7][3] = -1.946644
R[7][4] = -1.946659
R[7][5] = -1.946663
R[7][6] = -1.946664
R[7][7] = -1.946664
R[8][1] = -1.948451
R[8][2] = -1.948595
R[8][3] = -1.948627
R[8][4] = -1.948634
R[8][5] = -1.948636
R[8][6] = -1.948637
R[8][7] = -1.948637
R[8][8] = -1.948637
R[9][1] = -1.94953
R[9][2] = -1.949602
R[9][3] = -1.949618
R[9][4] = -1.949622
R[9][5] = -1.949623
R[9][6] = -1.949623
R[9][7] = -1.949623
R[9][8] = -1.949623
R[9][9] = -1.949623
R[10][1] = -1.95007
R[10][2] = -1.950106
R[10][3] = -1.950114
R[10][4] = -1.950116
R[10][5] = -1.950116
R[10][6] = -1.950116
R[10][7] = -1.950116
R[10][8] = -1.950116
R[10][9] = -1.950116
R[10][10] = -1.950116
R[11][1] = -1.95034
R[11][2] = -1.950358
R[11][3] = -1.950362
R[11][4] = -1.950363
R[11][5] = -1.950363
R[11][6] = -1.950363
R[11][7] = -1.950363
R[11][8] = -1.950363
R[11][9] = -1.950363
R[11][10] = -1.950363
R[11][11] = -1.950363
R[12][1] = -1.950475
R[12][2] = -1.950484
R[12][3] = -1.950486
R[12][4] = -1.950486
R[12][5] = -1.950486
R[12][6] = -1.950486
R[12][7] = -1.950486
R[12][8] = -1.950486
R[12][9] = -1.950486
R[12][10] = -1.950486
R[12][11] = -1.950486
R[12][12] = -1.950486
R[13][1] = -1.950542
R[13][2] = -1.950546
R[13][3] = -1.950547
R[13][4] = -1.950548
R[13][5] = -1.950548
R[13][6] = -1.950548
R[13][7] = -1.950548
R[13][8] = -1.950548
R[13][9] = -1.950548
R[13][10] = -1.950548
R[13][11] = -1.950548
R[13][12] = -1.950548
R[13][13] = -1.950548
R[14][1] = -1.950576
R[14][2] = -1.950578
R[14][3] = -1.950578
R[14][4] = -1.950579
R[14][5] = -1.950579
R[14][6] = -1.950579
R[14][7] = -1.950579
R[14][8] = -1.950579
```

```
R[14][8] = -1.950579
R[14][9] = -1.950579
R[14][10] = -1.950579
R[14][11] = -1.950579
R[14][12] = -1.950579
R[14][13] = -1.950579
R[14][14] = -1.950579
R[15][1] = -1.950593
R[15][2] = -1.950594
R[15][3] = -1.950594
R[15][4] = -1.950594
R[15][5] = -1.950594
R[15][6] = -1.950594
R[15][7] = -1.950594
R[15][8] = -1.950594
R[15][9] = -1.950594
R[15][10] = -1.950594
R[15][11] = -1.950594
R[15][12] = -1.950594
R[15][13] = -1.950594
R[15][14] = -1.950594
R[15][15] = -1.950594
R[16][1] = -1.950601
R[16][2] = -1.950602
R[16][3] = -1.950602
R[16][4] = -1.950602
R[16][5] = -1.950602
R[16][6] = -1.950602
R[16][7] = -1.950602
R[16][8] = -1.950602
R[16][9] = -1.950602
R[16][10] = -1.950602
R[16][11] = -1.950602
R[16][12] = -1.950602
R[16][13] = -1.950602
R[16][14] = -1.950602
R[16][15] = -1.950602
R[16][16] = -1.950602
R[17][1] = -1.950605
R[17][2] = -1.950606
R[17][3] = -1.950606
R[17][4] = -1.950606
R[17][5] = -1.950606
R[17][6] = -1.950606
R[17][7] = -1.950606
R[17][8] = -1.950606
R[17][9] = -1.950606
R[17][10] = -1.950606
R[17][11] = -1.950606
R[17][12] = -1.950606
R[17][13] = -1.950606
R[17][14] = -1.950606
R[17][15] = -1.950606
R[17][16] = -1.950606
R[17][17] = -1.950606
R[18][1] = -1.950607
R[18][2] = -1.950607
R[18][3] = -1.950608
R[18][4] = -1.950608
R[18][5] = -1.950608
R[18][6] = -1.950608
R[18][7] = -1.950608
R[18][8] = -1.950608
R[18][9] = -1.950608
R[18][10] = -1.950608
R[18][11] = -1.950608
R[18][12] = -1.950608
R[18][13] = -1.950608
R[18][14] = -1.950608
R[18][15] = -1.950608
R[18][16] = -1.950608
R[18][17] = -1.950608
R[18][18] = -1.950608
R[19][1] = -1.950608
R[19][2] = -1.950608
R[19][3] = -1.950608
R[19][4] = -1.950608
R[19][5] = -1.950608
R[19][6] = -1.950608
R[19][7] = -1.950608
R[19][8] = -1.950608
R[19][9] = -1.950608
R[19][10] = -1.950608
R[19][11] = -1.950608
R[19][12] = -1.950608
R[19][13] = -1.950608
R[19][14] = -1.950608
R[19][15] = -1.950608
R[19][16] = -1.950608
R[19][17] = -1.950608
R[19][18] = -1.950608
R[19][19] = -1.950608
I = -1.95060800000014114
```

# Numeric Analysis - Final Project

## Finding Equation Roots + Numerical Integration

### Question 14

שאלה מס' 14

עבור הפונקציה הבאה

$$f(x) = (xe^{-x^2+5x})(2x^2 - 3x - 5)$$

1. מצאו באמצעות שתי שיטות את כל השורשים האמיטיים הנמצאים בקטע  $[0,3]$
2. השתמשו בקירוב סימפסון ובשיטת רומברג למציאת הערך של האינטגרל בקטע  $[0.5,1]$

GitHub: <https://github.com/Maor-Ar/Numerical-Analysis-Hackathon/blob/main/Q14%20Finding%20Equation%20Roots%20Numerical%20Integration.py>

פתרון

מציאת שורשים ע"י שימוש בשיטת המיתר ובשיטת החציה

הרצאה של השיטות על הפונקציה הנדרשת

```
def MainFunction():

    roots = []
    x = sp.symbols('x')
    my_f = (x * sp.exp(-x**2 + 5*x)) * (2 * x ** 2 - 3 * x - 5)
    my_f_diff = lambda a: sp.diff(my_f, x).subs(x, a)
    checkRange = frange(0, 3, 0.1)
    epsilon = 0.00001
    print("\nFinding roots of the equation f(x) = ( Xe^(-X^2 + 5X) ) * (2X^2 - 3X - 5 )\n")
    print("Bisection Method on ( Xe^(-X^2 + 5X) ) * (2X^2 - 3X - 5 ) :\n")
    print(bcolors.OKGREEN, " ~ Odd multiplicity Roots ~", bcolors.ENDC)
    roots += BisectionMethodSections(func, checkRange, epsilon)
    print(bcolors.OKGREEN, "\n ~ Even multiplicity Roots ~", bcolors.ENDC)
    root = BisectionMethodSections(my_f_diff, checkRange, epsilon)
    if func(root[0]) == 0:
        roots += root
    else:
        print(bcolors.FAIL, " Not the root of the equation ", bcolors.ENDC)
    print("\nThere are ", bcolors.OKBLUE, len(roots), "roots found by Bisection Method", bcolors.ENDC)
    printFinalResult(roots)
    roots.clear()
    print("\nSecant Method on ( Xe^(-X^2 + 5X) ) * (2X^2 - 3X - 5 ) :\n")
    roots += SecantMethodInRangeIterations(func, checkRange, 0.0000001)
    print("\nThere are ", bcolors.OKBLUE, len(roots), "roots found by Secant Method ", bcolors.ENDC)
    printFinalResult(roots)
```

פלט סופי: (ופלט של האיטרציות)

There are 2 roots found by Bisection Method  
0.00000013230  
2.50000013230

There are 2 roots found by Secant Method  
0.00000013230  
2.50000013230

Finding roots of the equation  $f(X) = (X^e - X^2 + 5X) * (2X^2 - 3X - 5)$

Bisection Method on  $(X^e - X^2 + 5X) * (2X^2 - 3X - 5)$ :

~~ Odd multiplicity Roots ~~

root in 0.0

root in 2.5

~~ Even multiplicity Roots ~~

sign changing found between 1.9 - 2.0

iteration no. 0 a = 1.95 b = 2.8 f(a) = -323.662872538425 f(b) = 403.428793492736

iteration no. 1 a = 1.95 b = 1.975 f(a) = -323.662872538425 f(b) = 29.8351245951212

iteration no. 2 a = 1.9625 b = 1.975 f(a) = -149.493285314066 f(b) = 29.8351245951212

iteration no. 3 a = 1.96875 b = 1.975 f(a) = -60.4659786210877 f(b) = 29.8351245951212

iteration no. 4 a = 1.971875 b = 1.975 f(a) = -15.4736155142514 f(b) = 29.8351245951212

iteration no. 5 a = 1.971875 b = 1.9734575000000002 f(a) = -15.4736155142514 f(b) = 7.14133953250212

iteration no. 6 a = 1.9726525 b = 1.9734575000000002 f(a) = -4.17600837481596 f(b) = 7.14133953250212

iteration no. 7 a = 1.9726525 b = 1.9738466875 f(a) = -4.17600837481596 f(b) = 1.48020085507169

iteration no. 8 a = 1.9728515625 b = 1.9738466875 f(a) = -1.3465207992243 f(b) = 1.48020085507169

iteration no. 9 a = 1.9728515625 b = 1.9729492187500002 f(a) = -1.34852879992243 f(b) = 8.656854998618478

iteration no. 10 a = 1.9729492187500025 b = 1.9729492187500002 f(a) = -8.641456186011855 f(b) = 8.656854998618478

iteration no. 11 a = 1.9729492187500025 b = 1.9729492187500002 f(a) = -8.28708947653321 f(b) = 8.656854998618478

iteration no. 12 a = 1.972970117187501 b = 1.9729492187500002 f(a) = -0.11110714659469 f(b) = 0.0656854998618478

iteration no. 13 a = 1.9729491152343753 b = 1.9729492187500002 f(a) = -0.022711425453316 f(b) = 0.0656854998618478

after 13 iterations The root found is: 1.972949

Not the root of the equation

There are 2 roots found by Bisection Method

0.00000013230

2.50000013230

Secant Method on  $(X^e - X^2 + 5X) * (2X^2 - 3X - 5)$ :

iteration no. 0 Xi = 8.0 Xi+1 = 0.1 f(Xi) = -0.0

iteration no. 1 Xi = 8.1 Xi+1 = -0.0 f(Xi) = -0.8618629641364401

after 2 iterations The root found is: 0.0

iteration no. 0 Xi = 8.1 Xi+1 = 0.2 f(Xi) = -0.8618629641364401

iteration no. 1 Xi = 8.2 Xi+1 = 0.3 f(Xi) = -2.8833129866591217

iteration no. 2 Xi = 0.0573412027638384 f(Xi) = -0.394496221175293

iteration no. 3 Xi = 0.0834271699410766 Xi+1 = 0.08870078691695999 f(Xi) = -0.2112158018163986

iteration no. 4 Xi = 0.0808708691695999 Xi+1 = 0.081493698482747443 f(Xi) = -0.04567823362840489

iteration no. 5 Xi = 0.081493698482747443 Xi+1 = 7.055194869278889e-05 f(Xi) = -0.087531158594516731

iteration no. 6 Xi = 7.055194869278889e-05 Xi+1 = 5.8750808143369576e-07 f(Xi) = -0.00035289119392535844

iteration no. 7 Xi = 5.8750808143369576e-07 Xi+1 = 2.319895849388321e-10 f(Xi) = -2.9365537297850824e-06

after 8 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 8.2 Xi+1 = 0.3 f(Xi) = -2.8833129866591217

iteration no. 1 Xi = 8.3 Xi+1 = 0.1594458743685558 f(Xi) = -7.920859473386138

iteration no. 2 Xi = 0.15044485743685558 Xi+1 = 0.0912758731629499 f(Xi) = -1.3189829023769983

iteration no. 3 Xi = 0.89127587316828499 Xi+1 = 0.0394715658643351 f(Xi) = -8.7510987566021512

iteration no. 4 Xi = 0.8594715658643351 Xi+1 = 0.01430498498372127 f(Xi) = -0.2455783537378477

iteration no. 5 Xi = 0.01430498498372127 Xi+1 = 0.002703818676846207 f(Xi) = -0.077454075307169

iteration no. 6 Xi = 0.002703818676846207 Xi+1 = 0.002668238889557803 f(Xi) = -0.013746784859818787

iteration no. 7 Xi = 0.002668238889557803 Xi+1 = 3.097786861717573e-06 f(Xi) = -0.00181361608238655

iteration no. 8 Xi = 3.097786861717573e-06 Xi+1 = 5.3727237310186e-09 f(Xi) = -1.548907380210957e-05

after 9 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 8.3 Xi+1 = 0.4 f(Xi) = -7.028659473386138

iteration no. 1 Xi = 8.4 Xi+1 = 0.20966660408364238 f(Xi) = -14.89457989934694

iteration no. 2 Xi = 0.20966660408364238 Xi+1 = 0.1577902659012055 f(Xi) = -3.1710838029616796

iteration no. 3 Xi = 0.1577902659012055 Xi+1 = 0.08636899743067028 f(Xi) = -1.873741267656367

iteration no. 4 Xi = 0.08636899743067028 Xi+1 = 0.0431792511956183 f(Xi) = -0.69237972699564626

iteration no. 5 Xi = 0.0431792511956183 Xi+1 = 0.014868103787645885 f(Xi) = -0.2741513311984876

iteration no. 6 Xi = 0.014868103787645885 Xi+1 = 0.003043934112455135 f(Xi) = -0.0807067644365608

iteration no. 7 Xi = 0.003043934112455135 Xi+1 = 0.000209725407583408 f(Xi) = -0.0154811038518024513

iteration no. 8 Xi = 0.000209725407583408 Xi+1 = 0.0012021015356863684

iteration no. 9 Xi = 4.851611315068699e-06 Xi+1 = 5.443475102609081e-09 f(Xi) = -2.0258516215542387e-05

after 10 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 8.4 Xi+1 = 0.5 f(Xi) = -14.89457989934694

iteration no. 1 Xi = 8.5 Xi+1 = 0.29155596365662 f(Xi) = -28.46328750975588

iteration no. 2 Xi = 0.29155596365662 Xi+1 = 0.2298695366565271 f(Xi) = -6.562478381522936

iteration no. 3 Xi = 0.2298695366565271 Xi+1 = 0.1423741623799237 f(Xi) = -3.1424699591333

iteration no. 4 Xi = 0.1423741623799237 Xi+1 = 0.08234789117745876 f(Xi) = -1.5314542153624866

iteration no. 5 Xi = 0.08234789117745876 Xi+1 = 0.0392973572984984 f(Xi) = -0.667734710529576

iteration no. 6 Xi = 0.0392973572984984 Xi+1 = 0.01336602552787146 f(Xi) = -0.2442214043163782

iteration no. 7 Xi = 0.01336602552787146 Xi+1 = 0.00252635351991279 f(Xi) = -0.072846938180871

iteration no. 8 Xi = 0.00252635351991279 Xi+1 = 0.000182103768278857 f(Xi) = -0.012811617538756724

iteration no. 9 Xi = 0.000182103768278857 Xi+1 = 2.52846942505617e-06 f(Xi) = -0.009991975144824562

iteration no. 10 Xi = 2.52846942505617e-06 Xi+1 = 2.550276332945265e-09 f(Xi) = -1.2642713200834e-05

after 11 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 8.5 Xi+1 = 0.6 f(Xi) = -28.46328750975588

iteration no. 1 Xi = 8.6 Xi+1 = 0.3743732372973486 f(Xi) = -51.12016676101222

iteration no. 2 Xi = 0.3743732372973486 Xi+1 = 0.302428709387441 f(Xi) = -12.359443616146667

iteration no. 3 Xi = 0.302428709387441 Xi+1 = 0.28312211688368072 f(Xi) = -7.167102439431846

iteration no. 4 Xi = 0.28312211688368072 Xi+1 = 0.13267418841709698 f(Xi) = -2.9743393489816545

iteration no. 5 Xi = 0.13267418841709698 Xi+1 = 0.0735527475450991 f(Xi) = -1.357166485272447

iteration no. 6 Xi = 0.0735527475450991 Xi+1 = 0.03320070377379943 f(Xi) = -0.5505431513272199

iteration no. 7 Xi = 0.03320070377379943 Xi+1 = 0.01025419955959557 f(Xi) = -0.199577459980827

iteration no. 8 Xi = 0.01025419955959557 Xi+1 = 0.0016792402487975024 f(Xi) = -0.24592354834103344

iteration no. 9 Xi = 0.0016792402487975024 Xi+1 = 0.008475491599310284 f(Xi) = -0.088475491599310284

iteration no. 10 Xi = 0.008475491599310284 Xi+1 = 0.000465191599310284 f(Xi) = -0.000465191599310284

iteration no. 11 Xi = 0.000465191599310284 Xi+1 = 0.000182103768278857 f(Xi) = -0.000182103768278857

after 12 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 0.6 Xi+1 = 0.7 f(Xi) = -51.12016676101222

iteration no. 1 Xi = 0.7 Xi+1 = 0.4571705487630365 f(Xi) = -86.91122127973215

iteration no. 2 Xi = 0.4571705487630365 Xi+1 = 0.3762274743836385 f(Xi) = -21.71772031357612

iteration no. 3 Xi = 0.3762274743836385 Xi+1 = 0.2659708514601429 f(Xi) = -12.59353504075555

iteration no. 4 Xi = 0.2659708514601429 Xi+1 = 0.18512620853458656 f(Xi) = -5.29910876286989225

iteration no. 5 Xi = 0.18512620853458656 Xi+1 = 0.114175114786797542 f(Xi) = -2.476864579673408

iteration no. 6 Xi = 0.114175114786797542 Xi+1 = 0.06106144064564466 f(Xi) = -1.8603766705997397

iteration no. 7 Xi = 0.06106144064564466 Xi+1 = 0.0252147845489402 f(Xi) = -0.427279839798746976

iteration no. 8 Xi = 0.0252147845489402 Xi+1 = 0.0067918463614175 f(Xi) = -0.14504899412331662

iteration no. 9 Xi = 0.0067918463614175 Xi+1 = 0.00087219037567944 f(Xi) = -0.0352715855991224

iteration no. 10 Xi = 0.00087219037567944 Xi+1 = 3.240470173216332e-05 f(Xi) = -0.0043822975067539436

iteration no. 11 Xi = 3.240470173216332e-05 Xi+1 = 1.578527378735892862e-07 f(Xi) = -0.000162595291287127858

iteration no. 12 Xi = 1.578527378735892862e-07 Xi+1 = 2.86384607671382903e-11 f(Xi) = -7.891645912881296e-07

after 13 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 0.7 Xi+1 = 0.8 f(Xi) = -86.91122127973215

iteration no. 1 Xi = 0.8 Xi+1 = 0.5391743815152361 f(Xi) = -140.95187854477217

iteration no. 2 Xi = 0.5391743815152361 Xi+1 = 0.449504500937028 f(Xi) = -36.060771669652596

iteration no. 3 Xi = 0.449504500937028 Xi+1 = 0.3291822220890119 f(Xi) = -28.6622677706083

iteration no. 4 Xi = 0.3291822220890119 Xi+1 = 0.2392256162141808 f(Xi) = -8.8394209947769972142

iteration no. 5 Xi = 0.2392256162141808 Xi+1 = 0.1582807677696961 f(Xi) = -4.186497997981231

iteration no. 6 Xi = 0.1582807677696961 Xi+1 = 0.0943537247736958 f(Xi) = -1.847686831879954

iteration no. 7 Xi = 0.0943537247736958 Xi+1 = 0.054466046241524814 f(Xi) = -0.788995124508844

iteration no. 8 Xi = 0.054466046241524814 Xi+1 = 0.01711199507822215 f(Xi) = -0.3621013732281335

iteration no. 9 Xi = 0.01711199507822215 Xi+1 = 0.0037387975869161587 f(Xi) = -0.09412123289584344

iteration no. 10 Xi = 0.0037387975869161587 Xi+1 = 0.0003357799117452486 f(Xi) = -0.019420738750995254

iteration no. 11 Xi = 0.0003357799117452486 Xi+1 = 6.928220232436826e-06 f(Xi) = -0.0016280595758907297

iteration no. 12 Xi = 6.928220232436826e-06 Xi+1 = 1.30138534599530362e-08 f(Xi) = -3.4642445472242364e-05

after 13 iterations The root found is: 0.0

Already found that root.

iteration no. 0 Xi = 0.8 Xi+1 = 1.0 f(Xi) = -219.12540255027292

iteration no. 1 Xi = 1.0 Xi+1 = 0.6196935850878953 f(Xi) = -327.5889001988654

iteration no. 2 Xi = 0.6196935850878953 Xi+1 = 0.5211854474723571 f(Xi) = -56.982064615660015

iteration no. 3 Xi = 0.5211854474723571 Xi+1 = 0.3914625726188731 f(Xi) = -32.3876985738468

iteration no. 4 Xi = 0.3914625726188731 Xi+1 = 0.2932756663934823 f(Xi) = -13.95309962675614

iteration no. 5 Xi = 0.2932756663934823 Xi+1 = 0.2037080538760807 f

iteration no. 8 Xi = 1.2 Xi+1 = 1.3 f(Xi) = -656.085055555752  
iteration no. 1 Xi = 1.3 Xi+1 = 0.9979355730400718 f(Xi) = -880.7220873038946  
iteration no. 2 Xi = 0.987935575758400718 Xi+1 = -0.7721604929861589 f(Xi) = -226.5465466072181  
iteration no. 3 Xi = 0.7721604929861589 Xi+1 = -0.688722899264536 f(Xi) = -123.74539249527761  
iteration no. 4 Xi = 0.688722899264536 Xi+1 = -0.4836218591036633 f(Xi) = -53.65201005407855  
iteration no. 5 Xi = 0.4836218591036633 Xi+1 = -0.3685527698897743 f(Xi) = -25.705464178686498  
iteration no. 6 Xi = 0.3685527698897743 Xi+1 = -0.270114271927925 f(Xi) = -11.85161674958589  
iteration no. 7 Xi = 0.270114271927925 Xi+1 = -0.185166781619898 f(Xi) = -5.4698668507988252  
iteration no. 8 Xi = 0.185166781619898 Xi+1 = -0.11528108438021504 f(Xi) = -2.4779142243508546  
iteration no. 9 Xi = 0.11528108438021504 Xi+1 = -0.06154548470413126 f(Xi) = -1.076879572997842  
iteration no. 10 Xi = 0.06154548470413126 Xi+1 = -0.02558386682501416 f(Xi) = -0.4319747515072975  
iteration no. 11 Xi = 0.02558386682501416 Xi+1 = -0.006933201676808237 f(Xi) = -0.14747232823803486  
iteration no. 12 Xi = 0.006933201676808237 Xi+1 = -0.008920865359115887 f(Xi) = -0.0508056852661793045  
iteration no. 13 Xi = 0.008920865359115887 Xi+1 = -0.3419446595758106e-05 f(Xi) = -0.004533163657268098  
iteration no. 14 Xi = 3.419446595758106e-05 Xi+1 = 1.722381872985779e-07 f(Xi) = -0.0001710849948493442  
iteration no. 15 Xi = 1.722381872985779e-07 Xi+1 = 3.297821174194074e-11 f(Xi) = -8.611917671010582e-07  
after 16 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.3 Xi+1 = 1.4 f(Xi) = -880.7220873038946  
iteration no. 1 Xi = 1.4 Xi+1 = 0.9627140021242794 f(Xi) = -1141.842351071385  
iteration no. 2 Xi = 0.9627140021242794 Xi+1 = -0.8184691024737418 f(Xi) = -283.2264563201284  
iteration no. 3 Xi = 0.8184691024737418 Xi+1 = -0.6486578319502482 f(Xi) = -153.38958788154477  
iteration no. 4 Xi = 0.6486578319502482 Xi+1 = -0.51802311650572176 f(Xi) = -66.3887795443906  
iteration no. 5 Xi = 0.51882311650572176 Xi+1 = -0.39864970968413643 f(Xi) = -31.77510366758485  
iteration no. 6 Xi = 0.39864970968413643 Xi+1 = -0.296253983943237 f(Xi) = -14.671179668708879  
iteration no. 7 Xi = 0.296253983943237 Xi+1 = -0.20732577076666392 f(Xi) = -8.0129156662713345  
iteration no. 8 Xi = 0.20732577076666392 Xi+1 = -0.15319684974272773 f(Xi) = -3.1001635455428273  
iteration no. 9 Xi = 0.15319684974272773 Xi+1 = -0.07478892485401385 f(Xi) = -1.3662171664873564  
iteration no. 10 Xi = 0.07478892485401385 Xi+1 = -0.03578405292266768 f(Xi) = -0.563524655822286  
iteration no. 11 Xi = 0.03578405292266768 Xi+1 = -0.01856436718488561 f(Xi) = -0.20373614528552356  
iteration no. 12 Xi = 0.01856436718488561 Xi+1 = -0.00175608823635961 f(Xi) = -0.056801521277267596  
iteration no. 13 Xi = 0.00175608823635961 Xi+1 = -0.0001000698308367688 f(Xi) = -0.008867138855466721  
iteration no. 14 Xi = 0.0001000698308367688 Xi+1 = 9.784867013937799e-07 f(Xi) = -0.0085806296120363218  
iteration no. 15 Xi = 9.784867013937799e-07 Xi+1 = 5.48164450787469e-10 f(Xi) = -4.892460315249241e-06  
after 16 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.4 Xi+1 = 1.5 f(Xi) = -1141.842351071385  
iteration no. 1 Xi = 1.5 Xi+1 = 1.0027856966779497 f(Xi) = -1429.247013439725  
iteration no. 2 Xi = 1.0027856966779497 Xi+1 = -0.8528255832043493 f(Xi) = -330.99980584767556  
iteration no. 3 Xi = 0.8528255832043493 Xi+1 = -0.676642460948052 f(Xi) = -178.84883560713283  
iteration no. 4 Xi = 0.676642460948052 Xi+1 = -0.5436785959879532 f(Xi) = -77.12326476285152  
iteration no. 5 Xi = 0.5436785959879532 Xi+1 = -0.4205339783771426 f(Xi) = -36.9016634365116726  
iteration no. 6 Xi = 0.4205339783771426 Xi+1 = -0.3153364688384796 f(Xi) = -17.045428085159198  
iteration no. 7 Xi = 0.3153364688384796 Xi+1 = -0.2236174977769353 f(Xi) = -7.95591891236932  
iteration no. 8 Xi = 0.2236174977769353 Xi+1 = -0.1465596595893657 f(Xi) = -3.624842336543821  
iteration no. 9 Xi = 0.1465596595893657 Xi+1 = -0.0849237564121206 f(Xi) = -1.68090504426518  
iteration no. 10 Xi = 0.0849237564121206 Xi+1 = -0.04055794599915 f(Xi) = -0.6755643125363598  
iteration no. 11 Xi = 0.04055794599915 Xi+1 = -0.013805545015383886 f(Xi) = -0.25267837718154695  
iteration no. 12 Xi = 0.013805545015383886 Xi+1 = -0.00267216896446851 f(Xi) = -0.07455364723567616  
iteration no. 13 Xi = 0.00267216896446851 Xi+1 = -0.0001965413436824509 f(Xi) = -0.013562128626358926  
iteration no. 14 Xi = 0.0001965413436824509 Xi+1 = 2.915215384912808e-06 f(Xi) = -0.000937893678058866  
iteration no. 15 Xi = 2.915215384912808e-06 Xi+1 = 3.2066474435389295e-09 f(Xi) = -1.457649889644571e-05  
after 16 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.5 Xi+1 = 1.6 f(Xi) = -1429.247013439725  
iteration no. 1 Xi = 1.6 Xi+1 = 1.0176417659543504 f(Xi) = -1725.51069753287  
iteration no. 2 Xi = 1.0176417659543504 Xi+1 = -0.8693008916739648 f(Xi) = -350.3080151405417  
iteration no. 3 Xi = 0.8693008916739648 Xi+1 = -0.6899868501592983 f(Xi) = -192.18017408541724  
iteration no. 4 Xi = 0.6899868501592983 Xi+1 = -0.554304346655217 f(Xi) = -82.18687497945868  
iteration no. 5 Xi = 0.554304346655217 Xi+1 = -0.43019322326855353 f(Xi) = -39.41890118822374  
iteration no. 6 Xi = 0.43019322326855353 Xi+1 = -0.32382084063125015 f(Xi) = -18.18852828537846  
iteration no. 7 Xi = 0.32382084063125015 Xi+1 = -0.230823840737442817 f(Xi) = -8.481738945941997  
iteration no. 8 Xi = 0.230823840737442817 Xi+1 = -0.15256088866861965 f(Xi) = -3.878446742838102  
iteration no. 9 Xi = 0.15256088866861965 Xi+1 = -0.08953855389161213 f(Xi) = -1.7294228518543632  
iteration no. 10 Xi = 0.08953855389161213 Xi+1 = -0.04350442627998338 f(Xi) = -0.73001414566561539  
iteration no. 11 Xi = 0.04350442627998338 Xi+1 = -0.01540442284055135 f(Xi) = -0.27670875122754224  
iteration no. 12 Xi = 0.01540442284055135 Xi+1 = -0.003179446189181895 f(Xi) = -0.0839297766601212  
iteration no. 13 Xi = 0.003179446189181895 Xi+1 = -0.0002585929234079365 f(Xi) = -0.0161359851521321375  
iteration no. 14 Xi = 0.0002585929234079365 Xi+1 = -4.542987648251802e-06 f(Xi) = -0.00124919997634507  
iteration no. 15 Xi = 4.542987648251802e-06 Xi+1 = -6.5733842943678394e-09 f(Xi) = -2.27157118829242e-05  
after 16 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.6 Xi+1 = 1.7 f(Xi) = -1725.51069753287  
iteration no. 1 Xi = 1.7 Xi+1 = 0.984655248566416 f(Xi) = -2005.9712839069346  
iteration no. 2 Xi = 0.984655248566416 Xi+1 = -0.8545279157188146 f(Xi) = -308.7407589164997  
iteration no. 3 Xi = 0.8545279157188146 Xi+1 = -0.721243744522982 f(Xi) = -18.19150242135532  
iteration no. 4 Xi = 0.721243744522982 Xi+1 = -0.67214027214978448 f(Xi) = -7.53579102073266  
iteration no. 5 Xi = 0.67214027214978448 Xi+1 = -0.4181148666793705 f(Xi) = -36.46737709577716  
iteration no. 6 Xi = 0.4181148666793705 Xi+1 = -0.3134985678977304 f(Xi) = -16.765147651224  
iteration no. 7 Xi = 0.3134985678977304 Xi+1 = -0.2219280271885273 f(Xi) = -7.8250528282672849  
iteration no. 8 Xi = 0.2219280271885273 Xi+1 = -0.161907740786867 f(Xi) = -3.5675977686553098  
iteration no. 9 Xi = 0.161907740786867 Xi+1 = -0.0838691385625531 f(Xi) = -1.584628467808912  
iteration no. 10 Xi = 0.0838691385625531 Xi+1 = -0.039706212978017745 f(Xi) = -0.66342855253527  
iteration no. 11 Xi = 0.039706212978017745 Xi+1 = -0.013451276466134345 f(Xi) = -0.24755597237210865  
iteration no. 12 Xi = 0.013451276466134345 Xi+1 = -0.0025571177301399 f(Xi) = -0.07244763744282132  
iteration no. 13 Xi = 0.0025571177301399 Xi+1 = -0.0001841243732383034 f(Xi) = -0.013014383354397986  
iteration no. 14 Xi = 0.0001841243732383034 Xi+1 = -0.263225082458143e-06 f(Xi) = -0.000921571563568699  
iteration no. 15 Xi = 2.63225082458143e-06 Xi+1 = -2.70338377213721e-09 f(Xi) = -1.3116617815962087e-05  
after 16 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.7 Xi+1 = 1.8 f(Xi) = -2005.9712839069346  
iteration no. 1 Xi = 1.8 Xi+1 = 0.839948563237953 f(Xi) = -229.280980443527  
iteration no. 2 Xi = 0.839948563237953 Xi+1 = -0.716052214664425 f(Xi) = -168.90473799575116  
iteration no. 3 Xi = 0.716052214664425 Xi+1 = -0.5817380524119328 f(Xi) = -117.6826308838484  
iteration no. 4 Xi = 0.5817380524119328 Xi+1 = -0.4657464362681416 f(Xi) = -46.137546799765526  
iteration no. 5 Xi = 0.4657464362681416 Xi+1 = -0.3509382314099518 f(Xi) = -22.95048974331986  
iteration no. 6 Xi = 0.3509382314099518 Xi+1 = -0.2555308247923087 f(Xi) = -10.16242252616711  
iteration no. 7 Xi = 0.2555308247923087 Xi+1 = -0.17268798443899816 f(Xi) = -4.849962508087971  
iteration no. 8 Xi = 0.17268798443899816 Xi+1 = -0.10541028391969559 f(Xi) = -1.261572987315183  
iteration no. 9 Xi = 0.10541028391969559 Xi+1 = -0.0544711137341915 f(Xi) = -0.93489786166772  
iteration no. 10 Xi = 0.0544711137341915 Xi+1 = -0.02143215084464273 f(Xi) = -0.3677881826429123  
iteration no. 11 Xi = 0.02143215084464273 Xi+1 = -0.005283528332792916 f(Xi) = -0.120788539352588377  
iteration no. 12 Xi = 0.005283528332792916 Xi+1 = -0.0058569424268284 f(Xi) = -0.02721967369668051  
iteration no. 13 Xi = 0.00058569424268284 Xi+1 = -1.702620803223153e-05 f(Xi) = -0.00293811652543405  
iteration no. 14 Xi = 1.702620803223153e-05 Xi+1 = 5.574092322589363e-08 f(Xi) = -0.51391188210534e-05

after 15 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.8 Xi+1 = 1.9 f(Xi) = -2239.2098088443527  
iteration no. 1 Xi = 1.9 Xi+1 = 0.31118281020351557 f(Xi) = -2389.6117402695563  
iteration no. 2 Xi = 0.31118281020351557 Xi+1 = 0.30605733926180693 f(Xi) = -7.684018904934834  
iteration no. 3 Xi = 0.30605733926180693 Xi+1 = 0.18251354330048805 f(Xi) = -7.37793150670013  
iteration no. 4 Xi = 0.18251354330048805 Xi+1 = 0.1225835625866443 f(Xi) = -2.40997313799344747  
iteration no. 5 Xi = 0.1225835625866443 Xi+1 = 0.06415056112394782 f(Xi) = -1.1897260546049238  
iteration no. 6 Xi = 0.06415056112394782 Xi+1 = 0.027776523868985832 f(Xi) = -0.45645492590761577  
iteration no. 7 Xi = 0.027776523868985832 Xi+1 = 0.00775320681612598 f(Xi) = -0.1625057599388084  
iteration no. 8 Xi = 0.00775320681612598 Xi+1 = 0.00189511043323508 f(Xi) = -0.04048241076819653  
iteration no. 9 Xi = 0.00189511043323508 Xi+1 = 0.45892349262320796e-05 f(Xi) = -0.0054626631518248253  
iteration no. 10 Xi = 0.45892349262320796e-05 Xi+1 = 2.7810511924280867e-07 f(Xi) = -0.00022952072496234123  
iteration no. 11 Xi = 2.7810511924280867e-07 Xi+1 = 7.146205520916326e-11 f(Xi) = -1.3905277618043557e-06  
after 12 iterations The root found is: 0.0  
Already found that root.  
iteration no. 0 Xi = 1.9 Xi+1 = 2.0 f(Xi) = -2389.6117402695563  
iteration no. 1 Xi = 2.0 Xi+1 = -5.818129723381288 f(Xi) = -2420.5727609564105  
after 2 iterations The root found is: -5.81813  
root out of range.  
iteration no. 0 Xi = 2.0 Xi+1 = 2.1 f(Xi) = -2420.5727609564105  
iteration no. 1 Xi = 2.1 Xi+1 = 3.989735857585164 f(Xi) = -2298.9227092482156  
iteration no. 2 Xi = 3.989735857585164 Xi+1 = 2.8705675007791487 f(Xi) = 3339.0861562592577  
iteration no. 3 Xi = 2.8705675007791487 Xi+1 = 13.845160717314462 f(Xi) = 3718.286148485161  
after 4 iterations The root found is: 13.845161  
root out of range.  
iteration no. 0 Xi = 2.1 Xi+1 = 2.2 f(Xi) = -2298.9227092482156  
iteration no. 1 Xi = 2.2 Xi+1 = 2.86845277953747 f(Xi) = -1999.7601881023397  
iteration no. 2 Xi = 2.86845277953747 Xi+1 = 2.4346047880602546 f(Xi) = 3698.099910133359  
iteration no. 3 Xi = 2.4346047880602546 Xi+1 = 2.4920235035936903 f(Xi) = -564.1108162904685  
iteration no. 4 Xi = 2.4920235035936903 Xi+1 = 2.5004121109732864 f(Xi) = -71.89302678374267  
iteration no. 5 Xi = 2.5004121109732864 Xi+1 = 2.49997712567441 f(Xi) = 3.736933624775231  
iteration no. 6 Xi = 2.49997712567441 Xi+1 = 2.499999999354117 f(Xi) = -0.020736056994059008  
after 7 iterations The root found is: 2.5  
root out of range.  
iteration no. 0 Xi = 2.1 Xi+1 = 2.3 f(Xi) = -2298.9227092482156  
iteration no. 1 Xi = 2.3 Xi+1 = 2.6691671452403307 f(Xi) = -1511.0209989867487  
iteration no. 2 Xi = 2.6691671452403307 Xi+1 = 2.4822375256858553 f(Xi) = 1052.435938628929  
iteration no. 3 Xi = 2.4822375256858553 Xi+1 = -2.498898321776134 f(Xi) = -159.01521337864236  
iteration no. 4 Xi = 2.498898321776134 Xi+1 = 2.50040579459936424 f(Xi) = -9.97940510983344794  
iteration no. 5 Xi = 2.50040579459936424 Xi+1 = -2.499999984578773 f(Xi) = 0.12623478771463612  
after 6 iterations The root found is: 2.5  
root out of range.  
iteration no. 0 Xi = 2.2 Xi+1 = 2.4 f(Xi) = -1999.7601881023397  
iteration no. 1 Xi = 2.4 Xi+1 = 2.524175148330207 f(Xi) = -836.9850898586966  
iteration no. 2 Xi = 2.524175148330207 Xi+1 = -2.4988016243203936 f(Xi) = -22.67056331234105  
iteration no. 3 Xi = 2.4988016243203936 Xi+1 = -2.4999659792518466 f(Xi) = -17.367573005016517  
iteration no. 4 Xi = 2.4999659792518466 Xi+1 = -2.500000040171601 f(Xi) = -0.275765156660648  
after 5 iterations The root found is: 2.5  
root out of range.  
iteration no. 0 Xi = 2.4 Xi+1 = 2.5 f(Xi) = -836.9850898586966  
iteration no. 1 Xi = 2.5 Xi+1 = 2.0 f(Xi) = 0.0  
iteration no. 2 Xi = 2.6 Xi+1 = 2.5 f(Xi) = 960.071132484976  
iteration no. 3 Xi = 2.5 f(Xi) = 2.5  
iteration no. 4 Xi = 2.5 f(Xi) = 2.5  
iteration no. 5 Xi = 2.5 f(Xi) = 2.5  
iteration no. 6 Xi = 2.5 f(Xi) = 2.5  
iteration no. 7 Xi = 2.5 f(Xi) = 2.5  
iteration no. 8 Xi = 2.5 f(Xi) = 2.5  
iteration no. 9 Xi = 2.5 f(Xi) = 2.5  
iteration no. 10 Xi = 2.5 f(Xi) = 2.5  
iteration no. 11 Xi = 2.5 f(Xi) = 2.5  
iteration no. 12 Xi = 2.5 f(Xi) = 2.5  
iteration no. 13 Xi = 2.5 f(Xi) = 2.5  
iteration no. 14 Xi = 2.5 f(Xi) = 2.5  
iteration no. 15 Xi = 2.5 f(Xi) = 2.5  
iteration no. 16 Xi = 2.5 f(Xi) = 2.5  
iteration no. 17 Xi = 2.5 f(Xi) = 2.5  
iteration no. 18 Xi = 2.5 f(Xi) = 2.5  
iteration no. 19 Xi = 2.5 f(Xi) = 2.5  
iteration no. 20 Xi = 2.5 f(Xi) = 2.5  
iteration no. 21 Xi = 2.5 f(Xi) = 2.5  
iteration no. 22 Xi = 2.5 f(Xi) = 2.5  
iteration no. 23 Xi = 2.5 f(Xi) = 2.5  
iteration no. 24 Xi = 2.5 f(Xi) = 2.5  
iteration no. 25 Xi = 2.5 f(Xi) = 2.5  
iteration no. 26 Xi = 2.5 f(Xi) = 2.5  
iteration no. 27 Xi = 2.5 f(Xi) = 2.5  
iteration no. 28 Xi = 2.5 f(Xi) = 2.5  
iteration no. 29 Xi = 2.5 f(Xi) = 2.5  
iteration no. 30 Xi = 2.5 f(Xi) = 2.5  
iteration no. 31 Xi = 2.5 f(Xi) = 2.5  
iteration no. 32 Xi = 2.5 f(Xi) = 2.5  
iteration no. 33 Xi = 2.5 f(Xi) = 2.5  
iteration no. 34 Xi = 2.5 f(Xi) = 2.5  
iteration no. 35 Xi = 2.5 f(Xi) = 2.5  
iteration no. 36 Xi = 2.5 f(Xi) = 2.5  
iteration no. 37 Xi = 2.5 f(Xi) = 2.5  
iteration no. 38 Xi = 2.5 f(Xi) = 2.5  
iteration no. 39 Xi = 2.5 f(Xi) = 2.5  
iteration no. 40 Xi = 2.5 f(Xi) = 2.5  
iteration no. 41 Xi = 2.5 f(Xi) = 2.5  
iteration no. 42 Xi = 2.5 f(Xi) = 2.5  
iteration no. 43 Xi = 2.5 f(Xi) = 2.5  
iteration no. 44 Xi = 2.5 f(Xi) = 2.5  
iteration no. 45 Xi = 2.5 f(Xi) = 2.5  
iteration no. 46 Xi = 2.5 f(Xi) = 2.5  
iteration no. 47 Xi = 2.5 f(Xi) = 2.5  
iteration no. 48 Xi = 2.5 f(Xi) = 2.5  
iteration no. 49 Xi = 2.5 f(Xi) = 2.5  
iteration no. 50 Xi = 2.5 f(Xi) = 2.5  
iteration no. 51 Xi = 2.5 f(Xi) = 2.5  
iteration no. 52 Xi = 2.5 f(Xi) = 2.5  
iteration no. 53 Xi = 2.5 f(Xi) = 2.5  
iteration no. 54 Xi = 2.5 f(Xi) = 2.5  
iteration no. 55 Xi = 2.5 f(Xi) = 2.5  
iteration no. 56 Xi = 2.5 f(Xi) = 2.5  
iteration no

## שיטות אינטגרציה:

Finding area of the equation  $f(x) = (xe^{-x^2 + 5x}) * (2x^2 - 3x - 5)$

Simpson Rule on  $(xe^{-x^2 + 5x}) * (2x^2 - 3x - 5)$ :

$h = 0.025$

```

h/3 (-28.46320750907558 + 2 * -28.46320750907558 + -33.139567876553706 )
h/3 (-33.139567876553706 + 4 * -33.139567876553706 + 2 * -28.46320750907558 + -38.432155166191265 )
h/3 (-38.432155166191265 + 4 * -33.139567876553706 + 2 * -38.432155166191265 + -44.40349499272076 )
h/3 (-44.40349499272076 + 4 * -44.40349499272076 + 2 * -38.432155166191265 + -51.12016676101222 )
h/3 (-51.12016676101222 + 4 * -44.40349499272076 + 2 * -51.12016676101222 + -58.65278309174293 )
h/3 (-58.65278309174293 + 4 * -58.65278309174293 + 2 * -51.12016676101222 + -67.07592531664056 )
h/3 (-67.07592531664056 + 4 * -58.65278309174293 + 2 * -67.07592531664056 + -76.46802998273023 )
h/3 (-76.46802998273023 + 4 * -76.46802998273023 + 2 * -67.07592531664056 + -86.91122127973215 )
h/3 (-86.91122127973215 + 4 * -76.46802998273023 + 2 * -86.91122127973215 + -98.49108434753758 )
h/3 (-98.49108434753758 + 4 * -98.49108434753758 + 2 * -86.91122127973215 + -111.29637453918168 )
h/3 (-111.29637453918168 + 4 * -98.49108434753758 + 2 * -111.29637453918168 + -125.41865791622885 )
h/3 (-125.41865791622885 + 4 * -125.41865791622885 + 2 * -111.29637453918168 + -140.95187854477217 )
h/3 (-140.95187854477217 + 4 * -125.41865791622885 + 2 * -140.95187854477217 + -157.99184854740705 )
h/3 (-157.99184854740705 + 4 * -157.99184854740705 + 2 * -140.95187854477217 + -176.6356573547716 )
h/3 (-176.6356573547716 + 4 * -157.99184854740705 + 2 * -176.6356573547716 + -196.9809971936706 )
h/3 (-196.9809971936706 + 4 * -196.9809971936706 + 2 * -176.6356573547716 + -219.12540255027292 )
h/3 (-219.12540255027292 + 4 * -196.9809971936706 + 2 * -219.12540255027292 + -243.1654021577785 )
h/3 (-243.1654021577785 + 4 * -243.1654021577785 + 2 * -219.12540255027292 + -269.1955829780415 )
h/3 (-269.1955829780415 + 4 * -243.1654021577785 + 2 * -269.1955829780415 + -297.30756667385134 )
h/3 (-297.30756667385134 + 4 * -297.30756667385134 + 2 * -269.1955829780415 + -297.30756667385134 )
I = -67.1878750000013230

```

תוצאה סימפטיון:

I = -67.1878750000013230

תוצאה רומברג:

I = -66.7106900000132343

שימוש בשיטת רומברג נותן קירוב טוב יותר

```

Rumberg Rule on ( Xe^(-X^2 + 5X) ) * (2X^2 - 3X - 5) :

R[1][1] = 735.176578
R[2][1] = 334.257357
R[2][2] = 307.529409
R[3][1] = 133.77298
R[3][2] = 120.407355
R[3][3] = 117.437164
R[4][1] = 33.529805
R[4][2] = 26.846926
R[4][3] = 25.36184
R[4][4] = 25.00076
R[5][1] = -16.591837
R[5][2] = -19.933279
R[5][3] = -20.675822
R[5][4] = -20.856362
R[5][5] = -20.901188
R[6][1] = -41.652661
R[6][2] = -43.323382
R[6][3] = -43.694654
R[6][4] = -43.784924
R[6][5] = -43.807337
R[6][6] = -43.81293
R[7][1] = -54.183073
R[7][2] = -55.018434
R[7][3] = -55.204069
R[7][4] = -55.249204
R[7][5] = -55.260411
R[7][6] = -55.263208
R[7][7] = -55.263907
R[8][1] = -60.448279
R[8][2] = -60.865959
R[8][3] = -60.958777
R[8][4] = -60.981345
R[8][5] = -60.986948
R[8][6] = -60.988346
R[8][7] = -60.988696
R[8][8] = -60.988783
R[9][1] = -63.580882
R[9][2] = -63.789722
R[9][3] = -63.836131
R[9][4] = -63.847415
R[9][5] = -63.850216
R[9][6] = -63.850916
R[9][7] = -63.85109
R[9][8] = -63.851134
R[9][9] = -63.851145
R[10][1] = -65.147183
R[10][2] = -65.251603
R[10][3] = -65.274808
R[10][4] = -65.28045
R[10][5] = -65.281851
R[10][6] = -65.2822
R[10][7] = -65.282288
R[10][8] = -65.282309
R[10][9] = -65.282315
R[10][10] = -65.282316
R[11][1] = -65.930334
R[11][2] = -65.982544
R[11][3] = -65.994146
R[11][4] = -65.996967
R[11][5] = -65.997668
R[11][6] = -65.997843
R[11][7] = -65.997886
R[11][8] = -65.997897
R[11][9] = -65.9979
R[11][10] = -65.997901
R[11][11] = -65.997901
R[12][1] = -66.321909
R[12][2] = -66.348015
R[12][3] = -66.353816
R[12][4] = -66.355226
R[12][5] = -66.355576
R[12][6] = -66.355664
R[12][7] = -66.355686
R[12][8] = -66.355691
R[12][9] = -66.355692
R[12][10] = -66.355693
R[12][11] = -66.355693
R[12][12] = -66.355693
R[13][1] = -66.517697
R[13][2] = -66.53075
R[13][3] = -66.53365
R[13][4] = -66.534355
R[13][5] = -66.534531
R[13][6] = -66.534574
R[13][7] = -66.534585
R[13][8] = -66.534588
R[13][9] = -66.534589
R[13][10] = -66.534589
R[13][11] = -66.534589
R[13][12] = -66.534589
R[13][13] = -66.534589
R[14][1] = -66.615591
R[14][2] = -66.622117
R[14][3] = -66.623568
R[14][4] = -66.623592
R[14][5] = -66.624008
R[14][6] = -66.62403
R[14][7] = -66.624035
R[14][8] = -66.624036
R[14][9] = -66.624037

R[14][10] = -66.624037
R[14][11] = -66.624037
R[14][12] = -66.624037
R[14][13] = -66.624037
R[14][14] = -66.624037
R[15][1] = -66.664538
R[15][2] = -66.667801
R[15][3] = -66.668526
R[15][4] = -66.668703
R[15][5] = -66.668746
R[15][6] = -66.668757
R[15][7] = -66.66876
R[15][8] = -66.668761
R[15][9] = -66.668761
R[15][10] = -66.668761
R[15][11] = -66.668761
R[15][12] = -66.668761
R[15][13] = -66.668761
R[15][14] = -66.668761
R[15][15] = -66.668761
R[16][1] = -66.689011
R[16][2] = -66.690643
R[16][3] = -66.691006
R[16][4] = -66.691094
R[16][5] = -66.691116
R[16][6] = -66.691121
R[16][7] = -66.691122
R[16][8] = -66.691123
R[16][9] = -66.691123
R[16][10] = -66.691123
R[16][11] = -66.691123
R[16][12] = -66.691123
R[16][13] = -66.691123
R[16][14] = -66.691123
R[16][15] = -66.691123
R[16][16] = -66.691123
R[17][1] = -66.701248
R[17][2] = -66.702064
R[17][3] = -66.702245
R[17][4] = -66.702289
R[17][5] = -66.7023
R[17][6] = -66.702303
R[17][7] = -66.702304
R[17][8] = -66.702304
R[17][9] = -66.702304
R[17][10] = -66.702304
R[17][11] = -66.702304
R[17][12] = -66.702304
R[17][13] = -66.702304
R[17][14] = -66.702304
R[17][15] = -66.702304
R[17][16] = -66.702304
R[17][17] = -66.702304
R[18][1] = -66.707367
R[18][2] = -66.707774
R[18][3] = -66.707865
R[18][4] = -66.707887
R[18][5] = -66.707893
R[18][6] = -66.707894
R[18][7] = -66.707894
R[18][8] = -66.707894
R[18][9] = -66.707894
R[18][10] = -66.707894
R[18][11] = -66.707894
R[18][12] = -66.707894
R[18][13] = -66.707894
R[18][14] = -66.707894
R[18][15] = -66.707894
R[18][16] = -66.707894
R[18][17] = -66.707894
R[18][18] = -66.707894
R[19][1] = -66.710426
R[19][2] = -66.71063
R[19][3] = -66.710675
R[19][4] = -66.710686
R[19][5] = -66.710689
R[19][6] = -66.710689
R[19][7] = -66.71069
R[19][8] = -66.71069
R[19][9] = -66.71069
R[19][10] = -66.71069
R[19][11] = -66.71069
R[19][12] = -66.71069
R[19][13] = -66.71069
R[19][14] = -66.71069
R[19][15] = -66.71069
R[19][16] = -66.71069
R[19][17] = -66.71069
R[19][18] = -66.71069
R[19][19] = -66.71069
I = -66.71069000000132343

```

# Numeric Analysis - Final Project

## Systems of Linear Equations

### Question 28

#### • שאלה מס' 28

פתרו את המטריצה הבאה בשתי דרכים והשו בין התוצאות

$$\begin{pmatrix} 1 & 2 & -2 \\ 1 & 1 & 1 \\ 2 & 2 & 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 7 \\ 2 \\ 5 \end{pmatrix}$$

GitHub: <https://github.com/Maor-Ar/Numerical-Analysis-Hackathon/blob/main/Q28%20Systems%20of%20Linear%20Equations.py>

פתרונות

### Output

פתרנו על פי 3 שיטות את המטריצה

- לפי שיטת האלימינציה של גאוס.
- לפי שיטת פירוק LU.
- ולפי שיטת גאוס זידל.

ראוי לציין שלפי שיטת גאוס זידל נמצא שהfonקציה לא מתכנסת לאחר בדיקת אלכסון דומיננטי שלא נמצא, ועל ידי בדיקת ה Norm G שגם לא נמצא.

שאר הבדיקות הביאו פתרונות זהים (מספרים עגולים) בלי שגיאה בתוצאה.

# שיטת האלימינציה של גאוס

```
Matrix A:  
| 1 2 -2 |  
| 1 1 1 |  
| 2 2 1 |  
  
Vector b:  
| 7 |  
| 2 |  
| 5 |  
  
DET(A) = 1  
----The First method, according to the Elimination of Gauss Method (of course includes the use of pivoting and the calculation of COND)----  
|| A ||max = 5  
|| A(-1) ||max = 11.0  
CondA = ||A|| * ||A(-1)|| = 55.0  
GaussJordanElimination  
  
Matrix after exchanging rows for the 1 time:  
| 2 2 1 |  
| 1 2 -2 |  
| 1 1 1 |  
Matrix after making row 1 a pivot - (row 1) / 2 :  
| 1.0 1.0 0.5 |  
| 1 2 -2 |  
| 1 1 1 |  
Matrix after subtracting with row 1 making the lower part of the column 0  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 0.5 |  
Matrix after exchanging rows for the 2 time:  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 0.5 |  
Matrix after making row 2 a pivot - (row 2) / 1.0 :  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 0.5 |  
Matrix after subtracting with row 2 making the lower part of the column 0  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 0.5 |  
Matrix after exchanging rows for the 3 time:  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 0.5 |  
Matrix after making row 3 a pivot - (row 3) / 0.5 :  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 1.0 |  
Matrix after subtracting with row 3 making the lower part of the column 0  
| 1.0 1.0 0.5 |  
| 0.0 1.0 -2.5 |  
| 0.0 0.0 1.0 |  
Matrix after subtraction with row 2 making the upper part of the column 0  
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 0.0 1.0 |  
Matrix after inversion -  
| 4.0 -1.0 -6.0 |  
| -3.0 1.0 5.0 |  
| -1.0 0.0 2.0 |  
  
final result for x=(A^-1) * b  
  
Solution:  
| 1.0 |  
| 2.0 |  
| -1.0 |  
  
Solution to x0 value, in the required format.:  
1.000000132349  
  
Solution to x1 value, in the required format.:  
2.000000132349  
  
Solution to x2 value, in the required format.:  
-1.000000132349  
  
Solution to x1 value, in the required format.:  
2.000000132349  
  
Solution to x2 value, in the required format.:  
-1.000000132349
```



## שיטת פירוק ה-UL

# שיטת גאואזידל

----The Third method, according to the Gauss Seidel Method (including finding dominant diagonal)----

There isn't a dominant diagonal.

We will try to find dominant diagonal.

Couldn't find dominant diagonal.

```
| 2 2 1 |  
| 1 2 -2 |  
| 1 1 1 |
```

didn't find a dominant diagonal.

Matrix after exchanging rows for the 1 time:

```
| 2 0 0 |  
| 1 2 0 |  
| 1 1 1 |
```

Matrix after making row 1 a pivot - (row 1 )/ 2 :

```
| 1.0 0.0 0.0 |  
| 1 2 0 |  
| 1 1 1 |
```

Matrix after subtracting with row 1 making the lower part of the column 0

```
| 1.0 0.0 0.0 |  
| 0.0 2.0 0.0 |  
| 0.0 1.0 1.0 |
```

Matrix after exchanging rows for the 2 time:

```
| 1.0 0.0 0.0 |  
| 0.0 2.0 0.0 |  
| 0.0 1.0 1.0 |
```

Matrix after making row 2 a pivot - (row 2 )/ 2.0 :

```
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 1.0 1.0 |
```

Matrix after subtracting with row 2 making the lower part of the column 0

```
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 0.0 1.0 |
```

Matrix after exchanging rows for the 3 time:

```
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 0.0 1.0 |
```

Matrix after making row 3 a pivot - (row 3 )/ 1.0 :

```
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 0.0 1.0 |
```

Matrix after subtracting with row 3 making the lower part of the column 0

```
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 0.0 1.0 |
```

Matrix after subtracting with row 2 making the upper part of the column 0

```
| 1.0 0.0 0.0 |  
| 0.0 1.0 0.0 |  
| 0.0 0.0 1.0 |
```

The matrix isn't convergent.

Can't solve this matrix by Gauss Seidel Method

You can find other solutions above this one (LU disassembling and elimination of Gauss)

Process finished with exit code 0

# Numeric Analysis - Final Project

## Systems of Linear Equations

### Question 30

#### • שאלה מס' 30

פתרו את המטריצה הבאה בשתי דרכים והשו בין התוצאות

$$\begin{pmatrix} 0 & 1 & 2 \\ -2 & 1 & 0.5 \\ 1 & -2 & -0.5 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 0 \\ 4 \\ -4 \end{pmatrix}$$

GitHub: <https://github.com/Maor-Ar/Numerical-Analysis-Hackathon/blob/main/Q30%20Systems%20of%20Linear%20Equations.py>

פתרונות

### Output

פתרנו על פי 3 שיטות את המטריצה

- לפי שיטת האלימינציה של גאוס.
- לפי שיטת פירוק LU.
- ולפי שיטת גאוס זיידל.

כל השיטות החזירו את אותו הפתרון בرمת הדיק של 6 ספרות לאחר הנקודה מעבר למספרה הששית שיטת גאוס זיידל הציגה חסר דיק ששתי השיטות האחרות הגיעו אליהן עד רמת ה-machine precision

# שיטת האלימינציה של גאואו

```

Matrix A:
| 0 1 2 |
| -2 1 0.5 |
| 1 -2 -0.5 |

Vector b:
| 0 |
| 4 |
| -4 |

DET(A) = 5.5

---The First method according to the elimination of Gauss (of course includes the use of pivoting and the calculation of COND)---

|| A ||max = 3.5

|| A(-1) ||max = 1.1818181818181817

CondA = ||A|| * ||A(-1)|| = 4.136363636363636

GaussJordanElimination

Matrix after exchanging rows for the 1 time:
| -2 1 0.5 |
| 1 -2 -0.5 |
| 0 1 2 |

Matrix after making row 1 a pivot - (row 1) / -2 :
| 1.0 -0.5 -0.25 |
| 1 -2 -0.5 |
| 0 1 2.0 |

Matrix after subtracting with row 1 making the lower part of the column 0
| 1.0 -0.5 -0.25 |
| 0.0 -1.5 -0.25 |
| 0.0 1.0 2.0 |

Matrix after exchanging rows for the 2 time:
| 1.0 -0.5 -0.25 |
| 0.0 -1.5 -0.25 |
| 0.0 1.0 2.0 |

Matrix after making row 2 a pivot - (row 2) / -1.5 :
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 1.0 2.0 |

Matrix after subtracting with row 2 making the lower part of the column 0
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.833333333333333 |

Matrix after exchanging rows for the 3 time:
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.833333333333333 |

Matrix after making row 3 a pivot - (row 3) / 1.833333333333333 :
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.0 |

Matrix after subtracting with row 3 making the lower part of the column 0
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.0 |

Matrix after subtracting with row 2 making the upper part of the column 0
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |

Matrix after inversion -
| -0.6363636363636364 -0.2727272727272727 0.090909090909093 |
| -0.36363636363636365 -0.72727272727273 -0.09090909090909091 |
| 0.181818181818182 0.363636363636365 0.5454545454545455 |

final result for x=(A^-1) * b

Solution:
| -1.4545454545454546 |
| 1.4545454545454546 |
| -0.7272727272727273 |

Solution to x0 value, in the required format.:
-1.4545450000014149

Solution to x1 value, in the required format.:
1.4545450000014149

Solution to x2 value, in the required format.:
-0.7272730000014149

```

# שיטת פירוק LU

```
----The Second method according to the LU dismantling----
| -2 1 0.5 |
| 1 -2 -0.5 |
| 0 1 2 |
```

-----Building L and U matrices-----

Matrix after exchanging rows for the 1 time:

```
| -2.0 1.0 0.5 |
| 0.0 -1.5 -0.25 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after making row 1 a pivot - (row 1 )/ -2.0 :

```
| 1.0 -0.5 -0.25 |
| 0.0 -1.5 -0.25 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after subtracting with row 1 making the lower part of the column 0

```
| 1.0 -0.5 -0.25 |
| 0.0 -1.5 -0.25 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after exchanging rows for the 2 time:

```
| 1.0 -0.5 -0.25 |
| 0.0 -1.5 -0.25 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after making row 2 a pivot - (row 2 )/ -1.5 :

```
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after subtracting with row 2 making the lower part of the column 0

```
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after exchanging rows for the 3 time:

```
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.833333333333333 |
```

Matrix after making row 3 a pivot - (row 3 )/ 1.833333333333333 :

```
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.0 |
```

Matrix after subtracting with row 3 making the lower part of the column 0

```
| 1.0 -0.5 -0.25 |
| 0.0 1.0 0.1666666666666666 |
| 0.0 0.0 1.0 |
```

Matrix after subtracting with row 2 making the upper part of the column 0

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |
```

Matrix after exchanging rows for the 1 time:

```
| 1 0 0 |
| -0.5 1 0 |
| -0.0 -0.6666666666666666 1 |
```

Matrix after making row 1 a pivot - (row 1 )/ 1 :

```
| 1.0 0.0 0.0 |
| -0.5 1.0 0 |
| 0.0 -0.6666666666666666 1 |
```

Matrix after subtracting with row 1 making the lower part of the column 0

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 -0.6666666666666666 1.0 |
```

Matrix after exchanging rows for the 2 time:

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 -0.6666666666666666 1.0 |
```

Matrix after exchanging rows for the 2 time:

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 -0.6666666666666666 1.0 |
```

Matrix after making row 2 a pivot - (row 2 )/ 1.0 :

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 -0.6666666666666666 1.0 |
```

Matrix after subtracting with row 2 making the lower part of the column 0

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |
```

Matrix after exchanging rows for the 3 time:

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |
```

Matrix after making row 3 a pivot - (row 3 )/ 1.0 :

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |
```

Matrix after subtracting with row 3 making the lower part of the column 0

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |
```

Matrix after subtracting with row 2 making the upper part of the column 0

```
| 1.0 0.0 0.0 |
| 0.0 1.0 0.0 |
| 0.0 0.0 1.0 |
```

Matrix U:

```
| -2.0 1.0 0.5 |
| 0.0 -1.5 -0.25 |
| 0.0 0.0 1.833333333333333 |
```

Matrix L:

```
| 1 0 0 |
| -0.5 1 0 |
| -0.0 -0.6666666666666666 1 |
```

Matrix A=LU:

```
| -2.0 1.0 0.5 |
| 1.0 -2.0 -0.5 |
| 0.0 1.0 2.0 |
```

Solve Ax = b:

LU vector solution:

Solution:

```
| -1.4545454545454548 |
| 1.4545454545454546 |
| -0.7272727272727273 |
```

Solution to x0 value, in the required format.:

-1.4545450000014149

Solution to x1 value, in the required format.:

1.4545450000014149

Solution to x2 value, in the required format.:

-0.7272730000014149

# שיטת גאוא זיידל

```
----The Third method according to the Gauss Seidel Method (including finding dominant diagonal)----  
There is a dominant diagonal.  
Iteration no. 1 [-2.0, 1.0, -0.5]  
Iteration no. 2 [-1.625, 1.3125, -0.65625]  
Iteration no. 3 [-1.5078125, 1.41015625, -0.705078125]  
Iteration no. 4 [-1.47119140625, 1.440673828125, -0.7203369140625]  
Iteration no. 5 [-1.459747314453125, 1.4502105712890625, -0.7251052856445312]  
Iteration no. 6 [-1.456171035766016, 1.453190803527832, -0.726595401763916]  
Iteration no. 7 [-1.455053448677063, 1.4541221261024475, -0.7270610630512238]  
Iteration no. 8 [-1.4547042027115822, 1.4544131644070148, -0.7272065822035074]  
Iteration no. 9 [-1.4545950633473694, 1.4545041138771921, -0.7272520569385961]  
Iteration no. 10 [-1.454560957296053, 1.4545325355866225, -0.7272662677933113]  
Iteration no. 11 [-1.4545502991550165, 1.4545414173708195, -0.7272707086854098]  
Solution:  
| -1.4545502991550165 |  
| 1.4545414173708195 |  
| -0.7272707086854098 |  
  
Solution to x0 value, in the required format.:  
-1.454550000014149  
  
Solution to x1 value, in the required format.:  
1.4545410000014149  
  
Solution to x2 value, in the required format.:  
-0.7272710000014149  
  
Process finished with exit code 0
```

# Numeric Analysis - Final Project

## Interpolation and Extrapolation

### Question 32

• שאלה מס' 32

נתונה הטבלה הבאה:

x	F(x)
0.2	13.7241
0.35	13.9776
0.45	14.0625
0.6	13.9776
0.75	13.7241
0.85	13.3056
0.9	12.7281

העריכו את  $F(0.65)$  באמצעות שתי שיטות אינטראפולציה שונות

GitHub: <https://github.com/Maor-Ar/Numerical-Analysis-Hackathon/blob/main/Q32%20Interpolation%20and%20Extrapolation.py>

פתרונות

שיטות למציאת קירוב לנקודה נתונה לפי ערכי טבלה ע"י שימוש ב**שיטת אינטראפולאצית לגראנד'**, אלגוריתם נויל  
הרצאה על הטבלה הנדרשת – אינטראפולאצית לגראנד'

קלט ושליחת הטבלה והנקודה לפונקציה:

```
TableForProject = [[0.2, 13.7241], [0.35, 13.9776], [0.45, 14.0625], [0.6, 13.9776], [0.75, 13.7241], [0.85, 13.3056], [0.9, 12.7281]]  
point = 0.65  
Lagrange_interpolation(TableForProject, point)
```

פלט:  
הפלט יכלול את הדפסת הטבלה עצמה, את כל הפולינומים שנוצרו, את הפולינום הסופי שמורכב מחיבור של תמי הפולינומים בהתאם לנוסחה ואת הפתרון הסופי שהוא הצבה בפולינום הסופי את ערך הנקודה המתבקשת

```
----Lagrange_interpolation----  
Table values are :  
x0 is 0.2 F(X) is --> 13.7241  
x1 is 0.35 F(X) is --> 13.9776  
x2 is 0.45 F(X) is --> 14.0625  
x3 is 0.6 F(X) is --> 13.9776  
x4 is 0.75 F(X) is --> 13.7241  
x5 is 0.85 F(X) is --> 13.3056  
x6 is 0.9 F(X) is --> 12.7281  
L0 = (x-0.35)(x-0.45)(x-0.6)(x-0.75)(x-0.85)(x-0.9)/0.0037537499999999984  
L1 = (x-0.2)(x-0.45)(x-0.6)(x-0.75)(x-0.85)(x-0.9)/-0.00041250000000000001  
L2 = (x-0.2)(x-0.35)(x-0.6)(x-0.75)(x-0.85)(x-0.9)/0.00028250000000000002  
L3 = (x-0.2)(x-0.35)(x-0.45)(x-0.75)(x-0.85)(x-0.9)/-0.00016875  
L4 = (x-0.2)(x-0.35)(x-0.45)(x-0.6)(x-0.85)(x-0.9)/0.00014850000000000003  
L5 = (x-0.2)(x-0.35)(x-0.45)(x-0.6)(x-0.75)(x-0.9)/-0.00016250000000000007  
L6 = (x-0.2)/(x-0.35)/(x-0.45)/(x-0.6)/(x-0.75)/(x-0.85)/0.0003898125000000005  
Final polinom is (x-0.35)(x-0.45)(x-0.6)(x-0.75)(x-0.85)(x-0.9)/0.00375374999999984*13.7241 (x-0.2)(x-0.45)(x-0.6)(x-0.75)(x-0.85)(x-0.9)/-0.0004125000000000001*13.9776 (x-0.2)(x-0.35)(x-0.6)(x-0.75)(x-0.85)(x-0.9)/0.0002825000000000002*14.0625 (x-0.2)(x-0.35)(x-0.45)(x-0.75)(x-0.85)(x-0.9)/-0.00016875*13.9776 (x-0.2)(x-0.35)(x-0.45)(x-0.6)(x-0.85)(x-0.9)/0.0001485000000000003*13.7241 (x-0.2)(x-0.35)(x-0.45)(x-0.6)(x-0.75)(x-0.9)/-0.0001625000000000007*13.3056 (x-0.2)/(x-0.35)/(x-0.45)/(x-0.6)/(x-0.75)/(x-0.85)/0.0003898125000000005*12.7281  
Final solution by Lagrange interpolation 13.9022590000014012
```

פלט סופי:

פתרון סופי על פי הפורמט הנדרש :

Final solution by Lagrange interpolation 13.9022590000014012

תוצאה סופית: 13.902259

הרצה על הטבלה הנדרשת- אלגוריתם נויל

קלט ושליחת הטבלה והנקודה לפונקציה:

```
TableForProject = [[0.2,13.7241], [0.35,13.9776], [0.45, 14.0625], [0.6,13.9776], [0.75,13.7241], [0.85,13.3056], [0.9, 12.7281]]  
point =0.65  
Neville_interpolation(TableForProject,point)
```

פלט:  
הפלט יכול את הדפסת הטבלה עצמה, את כל הרכיבות של PN, זהה בעצם הפולינומיים ואת הפתרון הסופי שהוא הצבה בפולינום הסופי את ערך הנקודה המتابקשת

פלט סופי:

```
----Neville's_interpolation----  
P56=(x-0.85)*12.7281- (x-0.9)*13.3056)/(0.9-0.85) =15.615599999999995  
P45=(x-0.75)*13.3056- (x-0.85)*13.7241)/(0.85-0.75) =14.1426  
P34=(x-0.6)*13.7241- (x-0.75)*13.9776)/(0.75-0.6) =13.893099999999999  
P23=(x-0.45)*13.9776- (x-0.6)*14.0625)/(0.6-0.45) =13.949300000000001  
P12=(x-0.35)*14.0625- (x-0.45)*13.9776)/(0.45-0.35) =14.232300000000002  
P01=(x-0.2)*13.9776- (x-0.35)*13.7241)/(0.35-0.2) =14.484600000000004  
P46=(x-0.75)*15.6155999999995- (x-0.9)*14.1426)/(0.9-0.75) =13.160600000000004  
P35=(x-0.6)*14.1426- (x-0.85)*13.89309999999999)/(0.85-0.6) =13.943  
P24=(x-0.45)*13.89309999999999- (x-0.75)*13.949300000000001)/(0.75-0.45) =13.91183333333332  
P13=(x-0.35)*13.949300000000001- (x-0.6)*14.232300000000002)/(0.6-0.35) =13.892699999999998  
P02=(x-0.2)*14.232300000000002- (x-0.45)*14.484600000000004)/(0.45-0.2) =14.03046  
P36=(x-0.6)*13.160600000000004- (x-0.9)*13.943)/(0.9-0.6) =13.8126  
P25=(x-0.45)*13.943- (x-0.85)*13.9118333333332)/(0.85-0.45) =13.927416666666666  
P14=(x-0.35)*13.9118333333332- (x-0.75)*13.89269999999998)/(0.75-0.35) =13.90705  
P03=(x-0.2)*13.89269999999998- (x-0.6)*14.03046)/(0.6-0.2) =13.875479999999996  
P26=(x-0.45)*13.8126- (x-0.9)*13.92741666666666)/(0.9-0.45) =13.876387037037038  
P15=(x-0.35)*13.92741666666666- (x-0.85)*13.90705)/(0.85-0.35) =13.91927  
P04=(x-0.2)*13.90705- (x-0.75)*13.87547999999996)/(0.75-0.2) =13.901309999999999  
P16=(x-0.35)*13.876387037037038- (x-0.9)*13.91927)/(0.9-0.35) =13.895879292929292  
P05=(x-0.2)*13.91927- (x-0.85)*13.90130999999999)/(0.85-0.2) =13.913743846153848  
P06=(x-0.2)*13.895879292929292- (x-0.9)*13.913743846153848)/(0.9-0.2) =13.90225949050949  
Final solution by Neville's interpolation 13.9022590000014012
```

פתרון סופי על פי הפורמט הנדרש:

Final solution by Neville's interpolation 13.9022590000014012

תוצאה סופית: 13.902259

השווואה בין השיטות :

שתי השיטות נתנו לנו תוצאה זהה גם אינטראופלאציית לגראנץ' וגם אלגוריתם נויל

תוצאה סופית: 13.902259

