

# **Object-oriented Modelling and Programming in Engineering**

## **Assignment 1**

**Submitted By**

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## 1.0 Definition of Equation with Exact Solution

Definition of Equation

$$P(t) = a_1 \times t + \sin(2\pi f_1 t)$$

Where,

$$a_1 = \frac{[My\ registration\ number]}{40000} = \frac{126829}{40000} W \text{ and } f_1 = 2Hz.$$

From the above equation, the exact solution of the integration process is obtained as:

$$E(t) = \int_{t=0}^{t=20} P(t)dt = \left[ \frac{126829}{40000 \times 2} t^2 - \frac{\cos(2\pi f_1 t)}{2\pi} + C \right]_0^{20}$$

Substituting the time limit into the exact solution, we obtain energy as:

$$E(t) = 634.238J$$

## 2.0 Plotting the Function P(t)

The Function P(t) is plotted on the unity engine by using the default C# math class **“org.mariuszgromada.math.mxparser”** from .NET Framework and Function Plotter Class. The function plot can be seen in Figure 1 with P(t) on Y-axis and t on x-axis.

It should be noted that to plot this point, the variable **“numberOfFunctionPoints”** in the C# class was modified to 30.

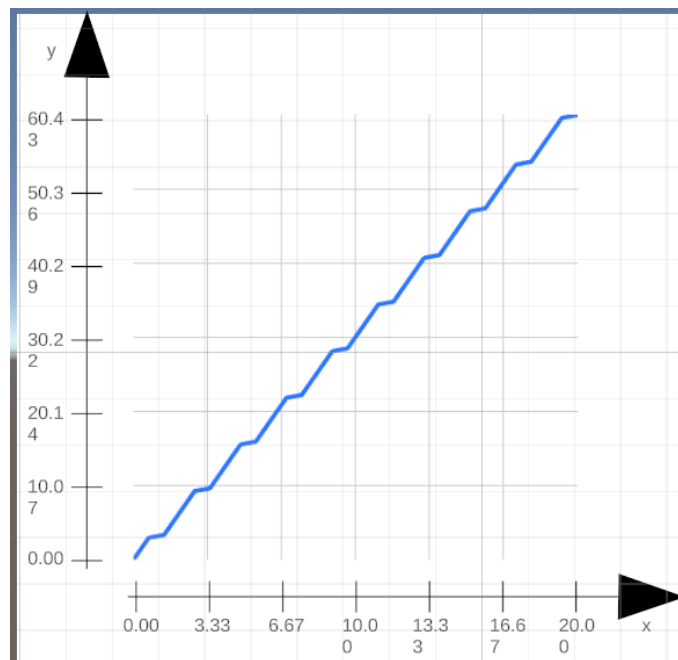
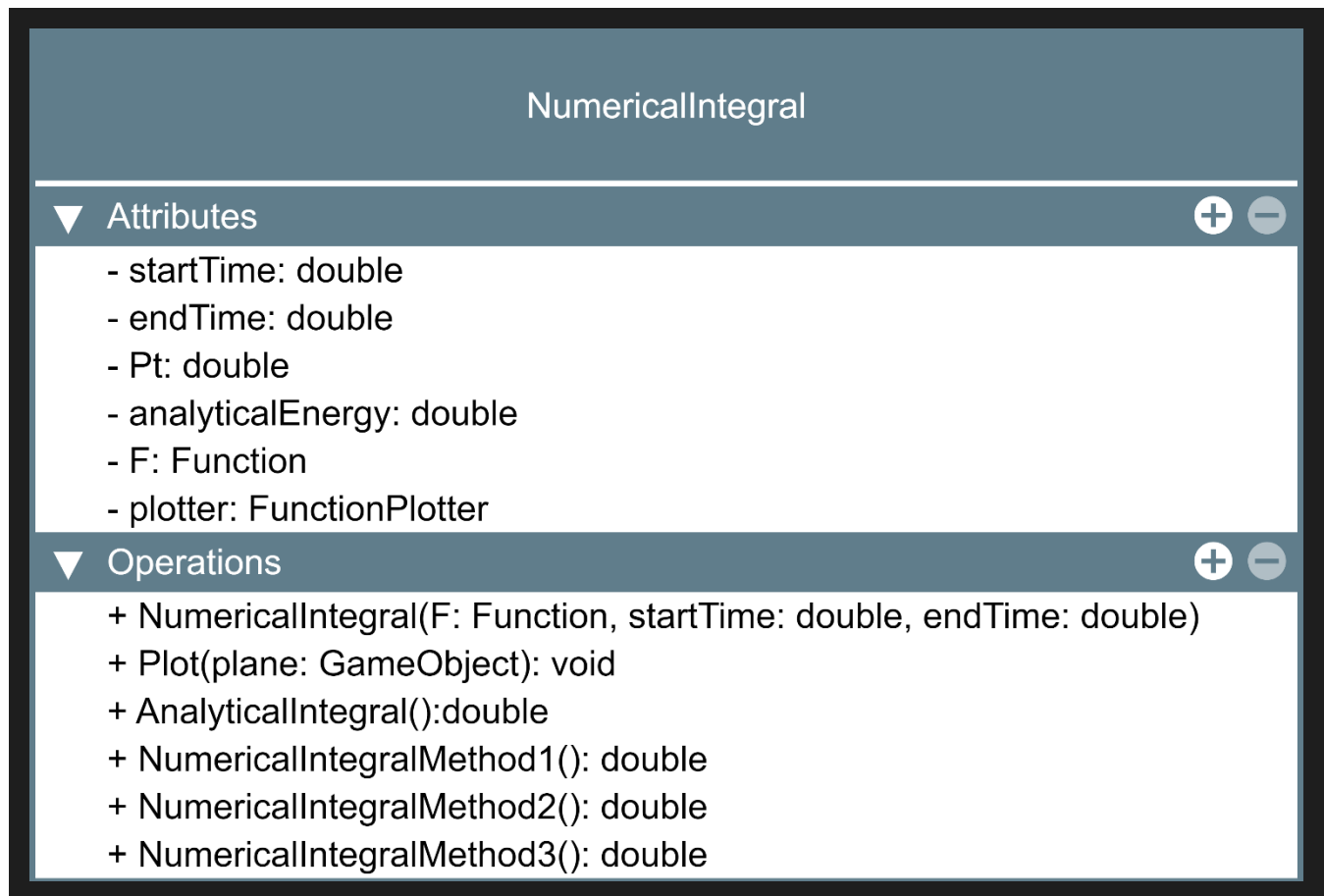


Figure 1: Plot of Function P(t) for  $0 \leq t \leq 20$

### 3.0 UML Diagram

The UML diagram used to implement the class Numerical Integral can be seen in figure 2 below.



*Figure 2: UML Diagram for Implementing the Numerical Integral.*

From the UML diagram above, the C# file where the methods are implemented is name **NumericalIntegral**, while the test file is named **PowerCalculations**.

### 4.0 Nassi-Schneiderman Diagrams

The Nassi-Schneiderman diagrams used in implementing the numerical integral using the three methods are shown below, and a extra one used to obtain the result of the analytical integral is also shown.

Figure 3 shows the Nassi-Schneiderman Diagram for Numerical Integral Method 1.

Figure 4 shows the Nassi-Schneiderman Diagram for Numerical Integral Method 2.

Figure 5 shows the Nassi-Schneiderman Diagram for Numerical Integral Method 3.

Figure 6 shows the Nassi-Schneiderman Diagram for calculating the exact analytical solution.

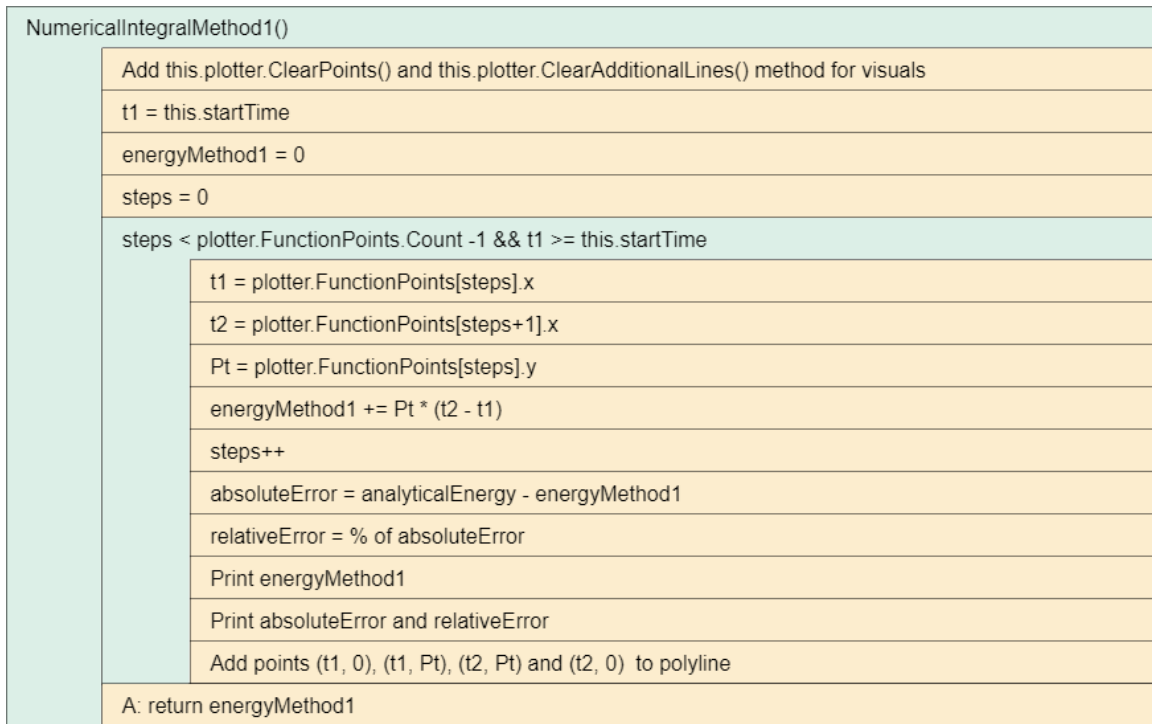


Figure 3: Nassi-Schneiderman's Diagram for Numerical Integral using Method 1

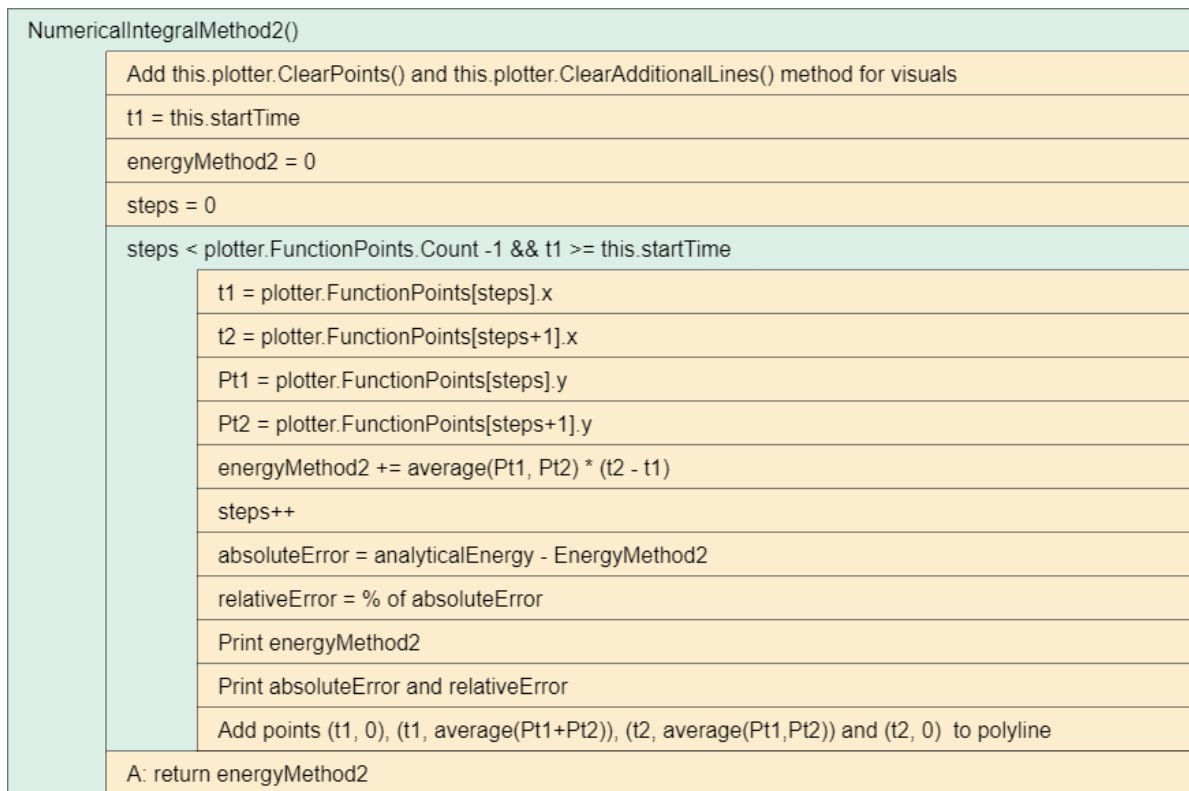


Figure 4: Nassi-Schneiderman's Diagram for Numerical Integral using Method 2

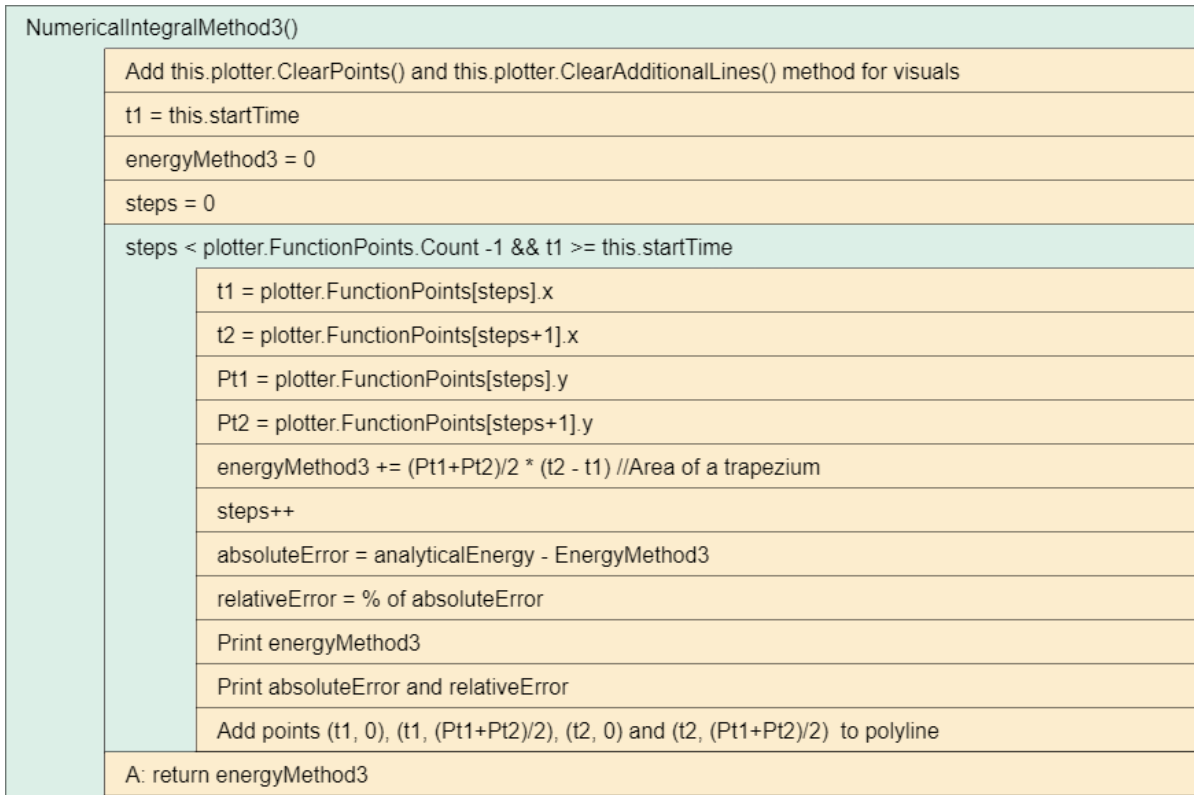


Figure 5: Nassi-Schneiderman's Diagram for Numerical Integral using Method 3

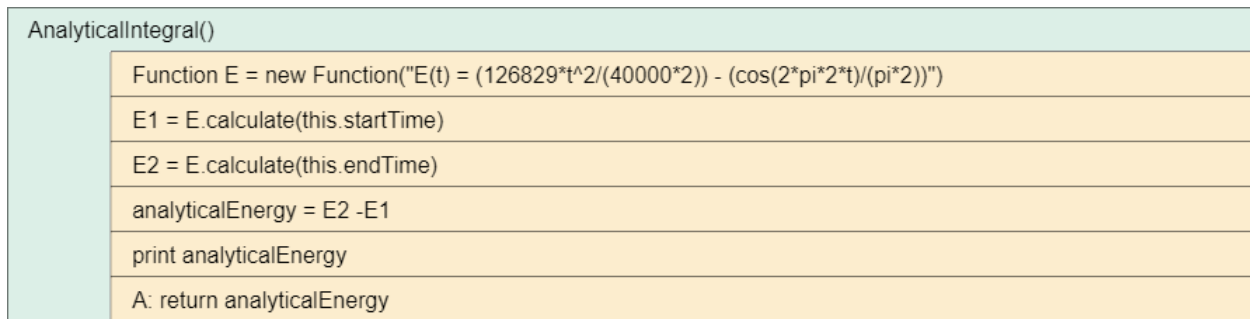


Figure 6: Nassi-Schneiderman Diagram for Analytical Integral

## 5.0 Results of Numerical Integral

The solution of the numerical integration are shown below. This includes the plots/visualization indicating the method, the result, absolute and relative error.

- **Numerical Integral Result Method 1:**

Figure 7 shows the graphical visualization of the numerical integral using method 1, and Figure 8 shows the result:

Numerical Integral  $E(t) = 572.72J$

Absolute Error = 61.428J

Relative Error = 9.69%

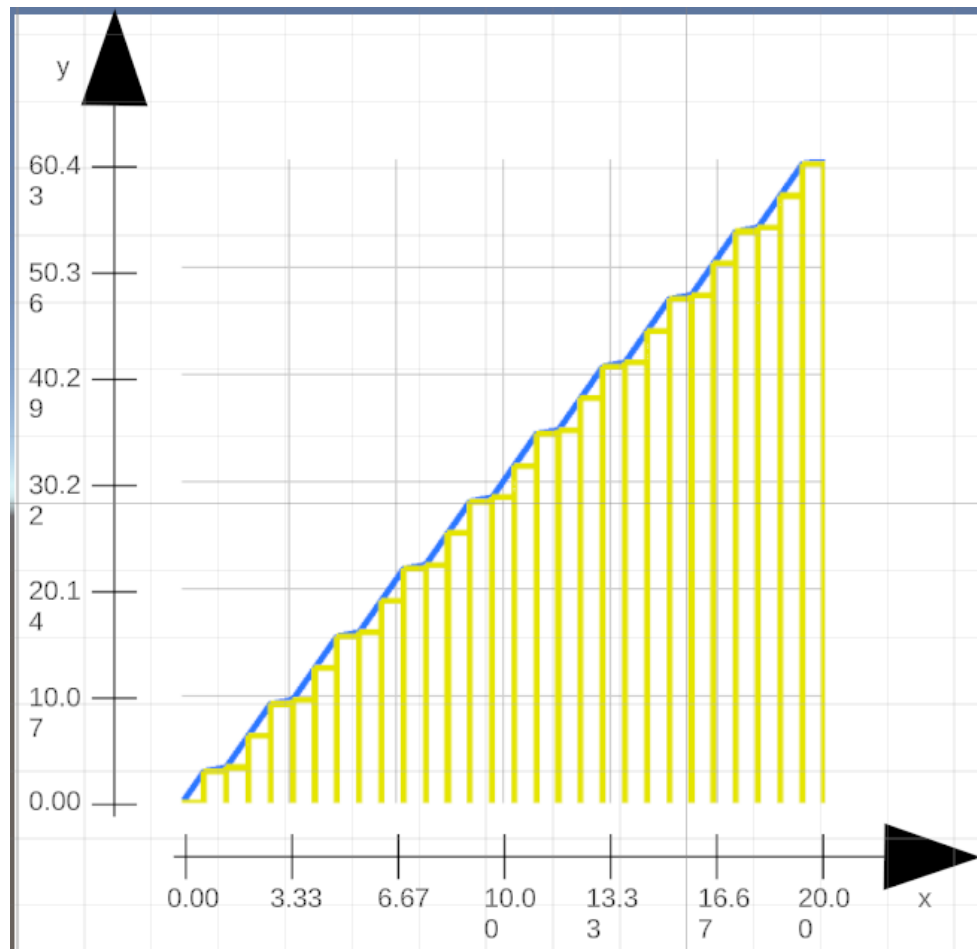


Figure 7: Plot of Numerical Integral using Method 1

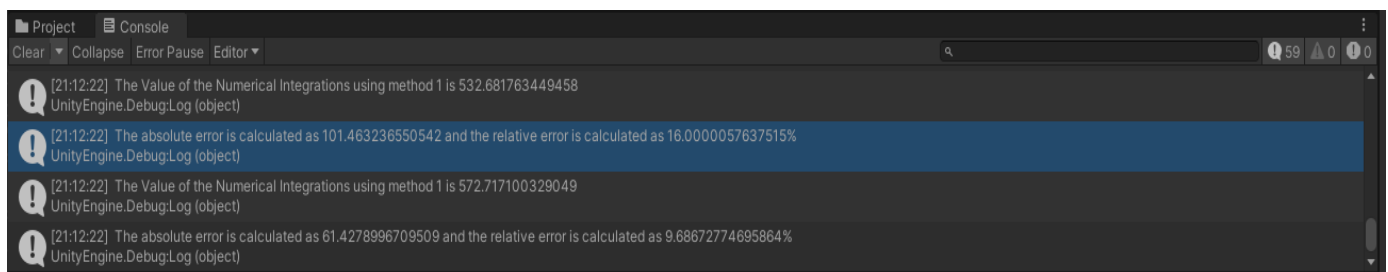


Figure 8: Image showing result of Numerical Integral Method 1, Absolute Error, and Relative Error

- **Numerical Integral Result Method 2:**

Figure 9 shows the graphical visualization of the numerical integral using method 2, and Figure 10 shows the result:

Numerical Integral  $E(t) = 592.862J$

Absolute Error = 41.283J

Relative Error = 6.51%

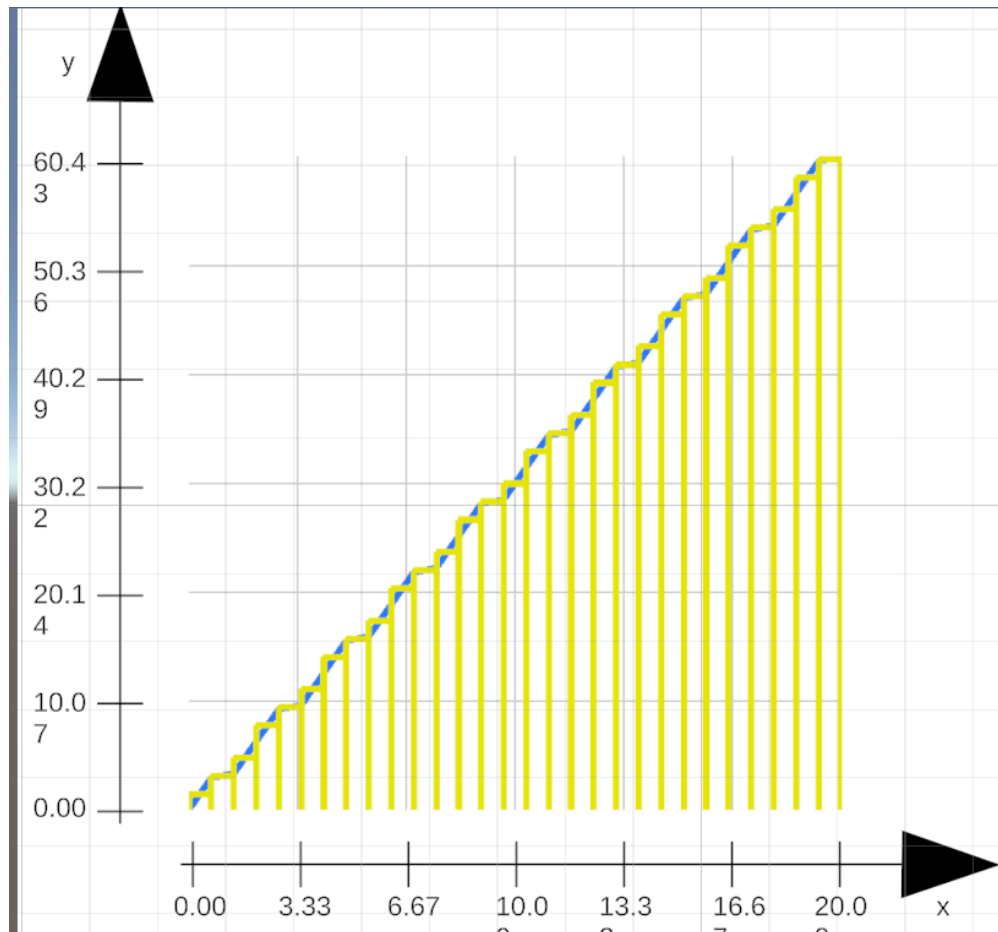


Figure 9: Plot of Numerical Integral using Method 2

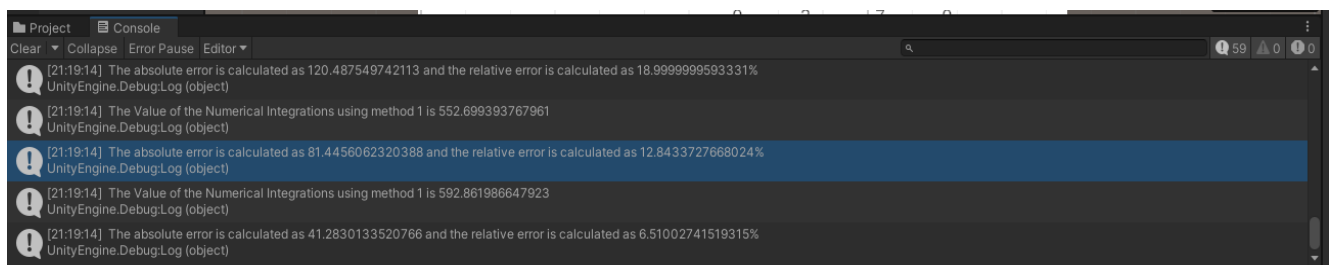


Figure 10: Image showing result of Numerical Integral Method 2, Absolute Error, and Relative Error

- **Numerical Integral Result Method 3:**

Figure 11 shows the graphical visualization of the numerical integral using method 3, and Figure 12 shows the result:

Numerical Integral  $E(t) = 592.862J$

Absolute Error = 41.283J

Relative Error = 6.51%

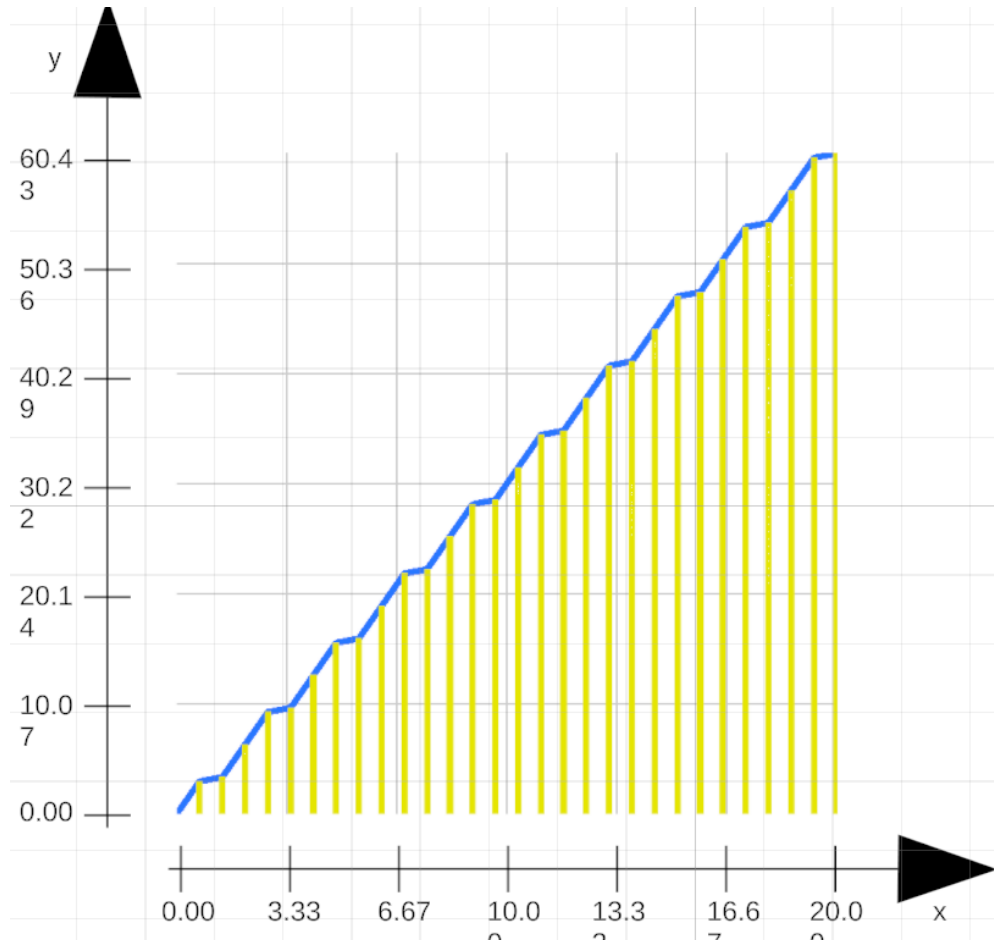


Figure 11: Plot of Numerical Integral using Method 3

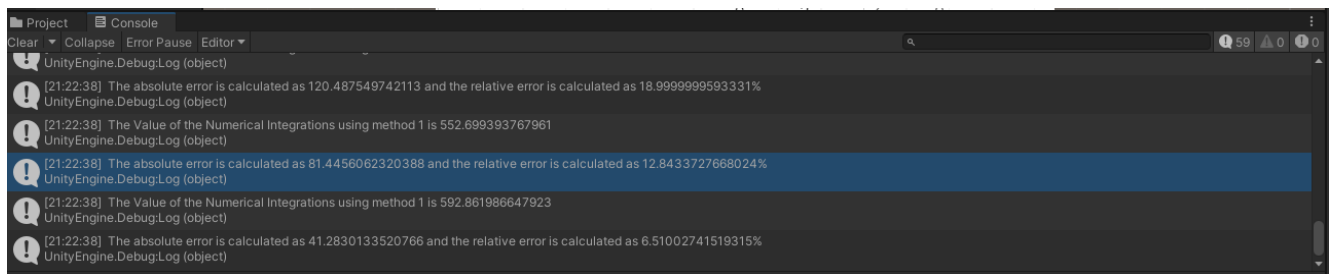


Figure 12: Image showing result of Numerical Integral Method 3, Absolute Error, and Relative Error