# PATUAKHALI SCIENCE AND TECHNOLOGY UNIVERSITY

**COURSE CODE CCE 312**
**Numerical Methods Sessional**

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Assignment 09
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# Differential Equations

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A differential equation is a mathematical equation that relates a function with its derivatives. In simpler terms, it describes how a quantity changes in relation to another quantity. Differential equations are fundamental in various fields such as physics, engineering, and economics, as they model dynamic systems and processes.

## Euler's Method

Euler's method is a simple and widely used numerical technique for solving ordinary differential equations (ODEs) with a given initial value. It is particularly useful for approximating solutions to first-order ODEs of the form:

$$\frac{dy}{dx} = f(x, y) \tag{1}$$

with an initial condition $y(x_0) = y_0$.

Let's consider an example,

$$\frac{dy}{dx} = x + y \tag{2}$$

$$y(0) = 1 \tag{3}$$

Let's import libraries first,

```
import numpy as np
import matplotlib.pyplot as plt
```

Our differential equation,

$$\frac{dy}{dx} = x + y \tag{4}$$

```
def f(x, y):
    return x + y
```

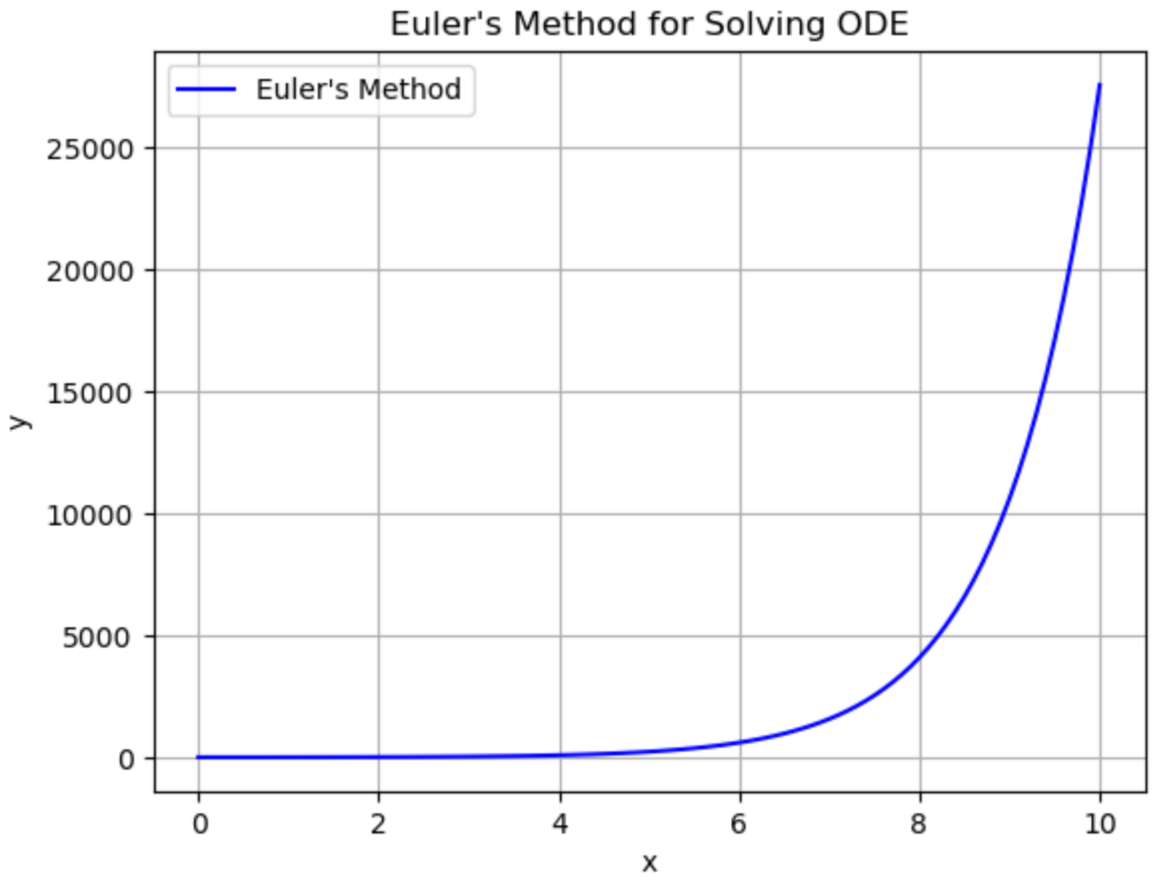
And our euler function,

```
def euler_method(f, x0, y0, h=0.1, n=100):
    x_values = [x0]
    y_values = [y0]

    for i in range(n):
        y0 = y0 + h * f(x0, y0)
        x0 = x0 + h
        x_values.append(x0)
        y_values.append(y0)

    return np.array(x_values), np.array(y_values)
```

Let’s plot and visualize the results,

```
# Initial conditions and parameters
x0 = 0
y0 = 1
h = 0.1  # Step size
n = 100  # Number of steps
x_values, y_values = euler_method(f, x0, y0, h, n)

# Plotting the results
plt.plot(x_values, y_values, label="Euler's Method", color='blue')
plt.title("Euler's Method for Solving ODE")
plt.xlabel('x')
plt.ylabel('y')
plt.legend()
```

```
plt.grid()
```

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