Numerical Techniques Laboratory

Assignment 2.1 | Tanishq Jasoria | 16MA20047

Solve the following equation

$$y'' - 2xy' - 2y = -4x$$

With respect to the following boundary conditions

$$y(0) - y'(0) = 0$$

$$2y(1) - y'(1) = 1$$

In [6]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
plt.rcParams['figure.figsize'] = [20, 30]
```

In [7]:

```
def A(x):
    return -2 * x
def B(x):
    return -2
def C(x):
    return -4 * x

def get_a(x, h):
    return 1/(h**2) - A(x)/(2.0 * h)
def get_b(x, h):
    return - 2/(h**2) + B(x)
def get_c(x, h):
    return 1/(h**2) + A(x)/(2.0 * h)
```

In [8]:

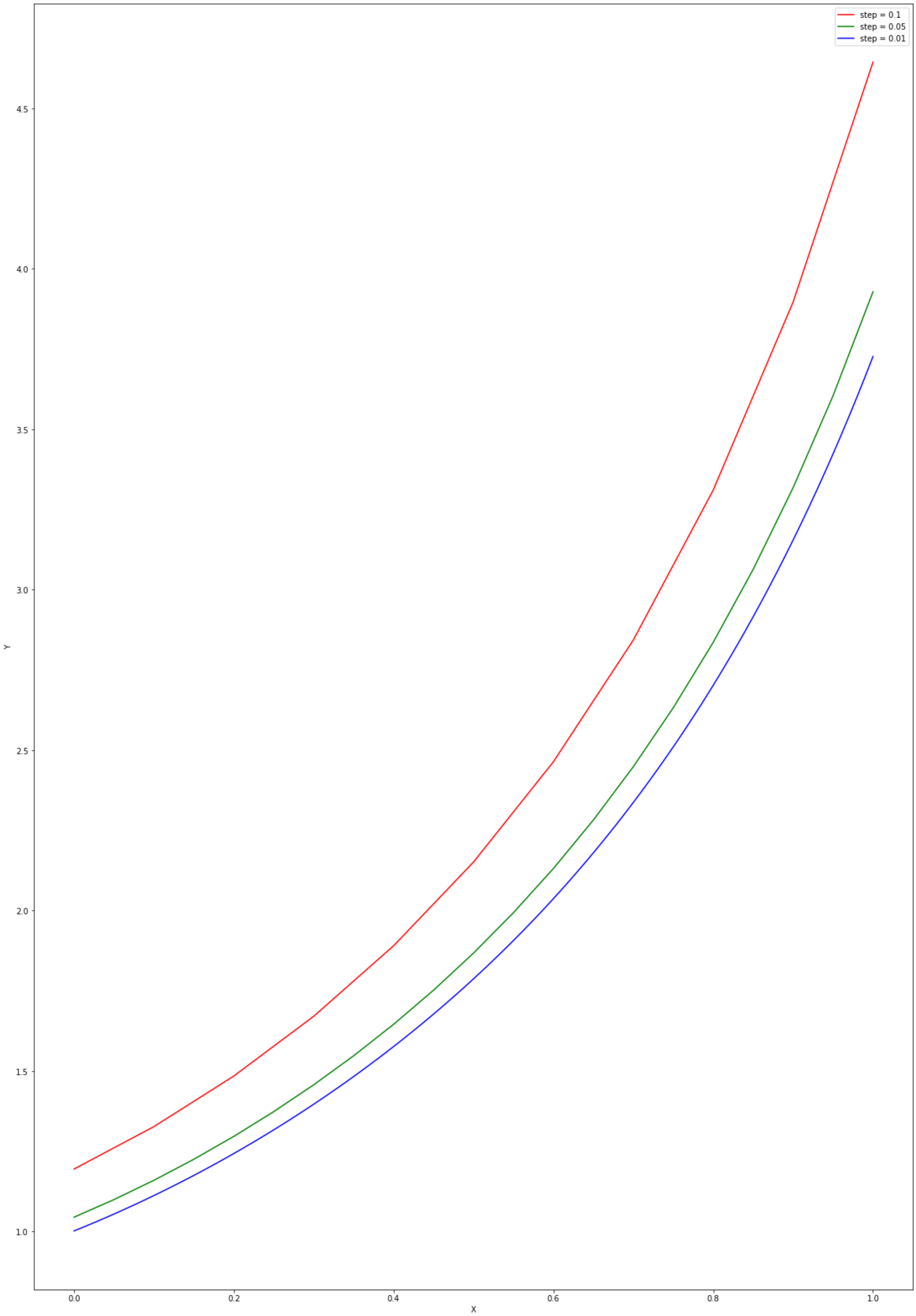
```
def ThomasAlgorithm(a, b, c, d, n):
    c_dash = np.zeros(n-1)
    d_dash = np.zeros(n-1)
    c_dash[0] = c[0] / b[0]
    d_dash[0] = d[0] / b[0]
    for itr in range(1, n-1):
        c_dash[itr] = c[itr] / (b[itr] - a[itr] * c_dash[itr-1])
        d_dash[itr] = (d[itr] - a[itr]*d_dash[itr-1]) / (b[itr] - a[itr] * c_dash[i

    y = np.zeros(n-1)
    y[n-2] = d_dash[n-2]

    for itr in reversed(range(n-2)):
        y[itr] = d_dash[itr] - c_dash[itr] * y[itr+1]

    return y
```

In [9]:

```
def TridiagonalBVP(x0, xn, h, n):
    x = [(x0 + itr * h) for itr in range(1, n)]
    #print x[n-1]
    a = [get_a(itr, h) for itr in x]
    b = [get_b(itr, h) for itr in x]
    c = [get_c(itr, h) for itr in x]
    d = [C(itr) for itr in x]

    b[0] += 4 / (2*h + 3) * a[0]
    c[0] += (-1) / (2*h + 3) * a[0]

    b[n-2] += 4 / (3 - 4*h) * c[n-2]
    a[n-2] += (-1) / (3 - 4*h) * c[n-2]
    d[n-2] += (2*h) / (3 - 4*h) * c[n-2]

    return ThomasAlgorithm(a, b, c, d, n)

def func(x0, xn, h = 0.1):
    return np.arange(x0, xn + h, h)
```

In [10]:

```
x0 = 0.0
xn = 1.0
steps = [0.1, 0.05, 0.01]
f = lambda xn, x0, step : int(np.ceil((xn-x0)/step))
colors = ['r', 'g', 'b']
labels = ["step = 0.1", "step = 0.05", "step = 0.01"]
# Creating vector that stores the steps
for step in steps:
    y = []
    x_range = func(x0, xn, step)
#     print(x_range)
    n = int(np.ceil((xn - x0)/step))
#     print(n)
    y[1:n] = TridiagonalBVP(x0, xn, step, n)
#     print(y)
    y.insert(0, 4 / (2*step + 3) * y[0] - 1 / (2*step + 3) * y[1])
#     print(y)
    y.append((4 * y[n-1] - y[n-2] - 2*step) / (3 - 4*step))
#     print(y)
    plt.xlabel('X')
    plt.ylabel('Y')
    i = steps.index(step)
    plt.plot( x_range, y, colors[i], label=labels[i])
    plt.gca().legend(labels)
```


step = 0.1
step = 0.05
step = 0.01
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Y
0.0
0.2
0.4
0.6
0.8
1.0
X