# Bahria University,

## Karachi Campus



LAB EXPERIMENT NO.

**\_10\_**

LIST OF TASKS

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| **TASK NO** | **OBJECTIVE** |
| 01 | Write a Python program that utilize Euler’s method for IVP: 𝑦′ = 2 − 𝑒−4𝑡 − 2𝑦 with y (0) = 1, step size of h=0.1 to find approximate values of the solution at t = 0.1, 0.2, 0.3, 0.4, and 0.5. |
| 02 | Write a Python program that utilize improved Euler’s method for IVP: 𝒚′ = 𝟏 𝒕 𝒕 − 𝒆𝟐 𝐬(𝟓𝐭) + 𝟓𝒆𝟐 𝐜𝐨𝐬(𝟓𝐭) + 𝐲 with y (0) = 0, to find approximate values of the 𝟐 solution at t = 1, t = 2, t = 3, t = 4, and t = 5. Use h = 0.1, h = 0.05, h = 0.01, h = 0.005 and h = 0.001 for the approximations. |
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Submitted On:

Date: 09/12/2024

**Task No 01:** Write a Python program that utilize Euler’s method for IVP: 𝑦′ = 2 − 𝑒−4𝑡 − 2𝑦 with y (0) = 1, step size of h=0.1 to find approximate values of the solution at t = 0.1, 0.2, 0.3, 0.4, and 0.5.

**Solution:**

import math

def f(t, y):

    return 2 - math.exp(-4 \* t) - 2 \* y

def euler\_method(t0, y0, h, t\_end):

    t = t0

    y = y0

    results = []

    while t <= t\_end:

        results.append((t, y))

        y = y + h \* f(t, y)

        t = round(t + h, 5)  # Avoid floating-point errors

    return results

t0 = 0

y0 = 1

h = 0.1

t\_end = 0.5

results = euler\_method(t0, y0, h, t\_end)

for t, y in results:

    print(f"t = {t:.1f}, y ≈ {y:.5f}")

**Output:**

**A screenshot of a computer

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**Task No 02:** Write a Python program that utilize improved Euler’s method for IVP: 𝒚′ = 𝟏 𝒕 𝒕 − 𝒆𝟐 𝐬(𝟓𝐭) + 𝟓𝒆𝟐 𝐜𝐨𝐬(𝟓𝐭) + 𝐲 with y (0) = 0, to find approximate values of the 𝟐 solution at t = 1, t = 2, t = 3, t = 4, and t = 5. Use h = 0.1, h = 0.05, h = 0.01, h = 0.005 and h = 0.001 for the approximations.

**Solution:**

import math

def f(t, y):

    return -0.5 \* math.exp(t) \* math.sin(5 \* t) + 5 \* math.exp(t) \* math.cos(5 \* t) + y

def improved\_euler\_method(t0, y0, h, t\_end):

    t = t0

    y = y0

    results = []

    while t <= t\_end:

        results.append((t, y))

        k1 = f(t, y)

        k2 = f(t + h, y + h \* k1)

        y = y + h \* (k1 + k2) / 2

        t = round(t + h, 5)  # Avoid floating-point errors

    return results

t0 = 0

y0 = 0

step\_sizes = [0.1, 0.05, 0.01, 0.005, 0.001]

t\_end = 5

for h in step\_sizes:

    print(f"\nStep size h = {h}")

    results = improved\_euler\_method(t0, y0, h, t\_end)

    for t, y in results:

        if abs(t - round(t)) < 1e-9:  # Check if t is close to an integer

            print(f"t = {t:.0f}, y ≈ {y:.5f}")

**Output:**

**A screenshot of a math equation

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