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import math
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd

t = 0          #time s
y = 2          #water level m
A = 850        #Area, m^2
Q = 325        #flow rate m^3/2
alpha = 200    #constant m^3/2 / s
h = .5        #step size s
maxTime = 10   #simulation limit s

#Store values to be produced then plotted from euler's
time_values = []
y_values = []

#defines dy/dt
def forcingfunc(time, ylevel):
    return 2 * (Q/A) * math.sin(time)**2 - ((alpha)/A * ((1 + ylevel)**(3/2)))

#loop through estimations
while t < maxTime:
    #print("Time: %2f, Y-level: %f " % (t, y))
    time_values.append(t)
    y_values.append(y)
    y = y + forcingfunc(t, y)*h
    t += .5

#appending last time
time_values.append(t)
y_values.append(y)
#print("Time: %2f, Y-level: %f " % (t, y))

# Plotting the water level over time
plt.figure(figsize=(8, 6))
plt.plot(time_values, y_values, marker='o', linestyle='-', color='b')
plt.title('Water Level Over Time Using Euler\'s Method')
plt.xlabel('Time (s)')
plt.ylabel('Water Level (m)')
plt.grid(True)
plt.show()

data = {
    ('Time') : time_values,
    ('Water level') : y_values
}

df = pd.DataFrame(data)
print(df)

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