MA-221(Numerical Analysis)
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Lab Assignment-13
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Instructions

- Solve each problem using Python, C++, and MATLAB.

Question 1: Trapezoidal Rule on Temperature Rise

Background

In a chemical process, engineers monitor the temperature of a reactor every minute during startup. They need to estimate the total temperature exposure (integral of temperature over time) to ensure safe operation and optimize thermal performance.

Data Table

Time (min)	Temperature (°C)
0	25.0
1	27.2
2	30.1
3	33.8
4	38.2
5	43.4
6	49.3
7	56.1
8	63.7
9	72.1
10	81.4

Tasks

1. Use the Trapezoidal Rule to estimate the area under the temperature-time curve.
2. Analyze if temperature increase is uniform or accelerating.
3. Recalculate area using composite Trapezoidal Rule with 2, 4, 6 segments.
4. Compare your estimates and discuss convergence.

Question 2: Simpson's 1/3 Rule on Delivery Distance

Background

A logistics company tracks the position of a delivery truck at 5-minute intervals. To analyze delivery efficiency, they estimate the total distance traveled using Simpson's 1/3 Rule, which helps assess route optimization.

Data Table

Time (min)	Distance (km)
0	0.0
5	5.4
10	10.6
15	15.7
20	20.7
25	25.4
30	29.8
35	33.9
40	37.5
45	40.6
50	43.0

Tasks

1. Use Simpson's 1/3 Rule to approximate total distance traveled.
2. Recalculate using only even-numbered intervals.
3. Evaluate if this approximation is realistic.
4. Compare it to the Trapezoidal result.

Question 3. Simpson's 3/8 Rule on Atmospheric Pressure

Background

Weather balloons are used to measure atmospheric pressure at different altitudes. Meteorologists use this data to understand pressure changes with height and estimate pressure variation using Simpson's 3/8 Rule for better forecasting.

Data Table

Altitude (m)	Pressure (hPa)
0	1013
100	1001
200	990
300	979
400	969
500	959
600	950
700	941
800	933
900	925
1000	917

Tasks

1. Estimate the area under the pressure-altitude curve using Simpson's 3/8 Rule.
2. Use three different segments (n = 3, 6, 9).
3. Compare results with Trapezoidal and Simpson's 1/3 Rule.
4. Comment on pressure loss with altitude.

Question 4. Trapezoidal Rule for Water Level Monitoring

Background

In flood management systems, water levels are recorded hourly. Engineers estimate the total rise in water volume using the Trapezoidal Rule to ensure timely response during potential flood events.

Data Table

Time (hr)	Water Level (m)
0	1.2
1	1.4
2	1.9
3	2.5
4	3.2
5	3.9
6	4.7
7	5.6
8	6.4
9	7.1
10	7.7

Tasks

1. Apply the Trapezoidal Rule to estimate volume of water passed.
2. Determine accuracy improvement with more subdivisions.
3. Compare to Simpson's 1/3 Rule estimate.

Question 5. Simpson's 1/3 Rule for Cooling Rate

Background

During a thermal experiment, the rate at which an object cools is measured at 10-second intervals. Scientists use Simpson's 1/3 Rule to estimate the total heat loss and understand the thermal behavior over time.

Data Table

Time (s)	Temperature (°C)
0	95.0
10	88.2
20	81.7
30	75.4
40	69.3
50	63.3
60	57.5
70	51.9
80	46.4
90	41.0
100	36.0

Tasks

1. Use Simpson's 1/3 Rule to find heat lost.
2. Break interval into 2, 4, and 6 segments and observe changes.

3. Comment on nature of cooling.
4. Compare with real experimental value if given.

Question 6. Simpson's 3/8 Rule for Drug Absorption in Bloodstream

Background

Pharmacologists measure drug concentration in the bloodstream at 10-minute intervals. To understand how quickly the drug is absorbed, they estimate the total drug exposure using Simpson's 3/8 Rule.

Data Table

Time (min)	Concentration (mg/L)
0	0.0
10	2.5
20	5.6
30	9.0
40	12.3
50	14.8
60	16.2
70	17.1
80	17.5
90	17.6
100	17.6

Tasks

1. Estimate area under concentration-time curve using Simpson's 3/8 Rule.
2. Use 3 and 6 segment approximations.
3. Compare with trapezoidal and Simpson's 1/3 results.
4. Estimate peak absorption.