Assignment 4 - Computational Mathematics

Week 5 & 6

Instructions

For each problem, please include:

- Source code with comments explaining all important steps.
- A screenshot of the program output and explanation.
- Show all intermediate results, including tables and graphs where applicable.
- Provide detailed explanations for your approaches and results.

Save your answers as a PDF report and submit it to the Moodle.

Part 1: Empirical Laws and Curve Fitting

Task 1: Linear Curve Fitting.

Fit a straight line y=mx+c to the following data points using the Method of Least Squares:

x=[1,2,3,4,5] y=[3,6,8,11,15]

Required:

1. Compute the slope (m) and intercept (c).
2. Plot the data points and the fitted line on the same graph.

Task 2: Polynomial Curve Fitting.

Fit a quadratic curve y=ax^2+bx+c to the following data points:

x=[0,1,2,3,4] y=[2,3,6,11,18]

Required:

1. Determine the coefficients a,b,c using the Method of Least Squares.
2. Plot the original data points and the fitted curve on the same graph.

Task 3: Exponential Curve Fitting.

Fit an exponential model y= a* e^(bx) to the following data:

x=[1,2,3,4,5] y=[2.5,4.7,8.8,16.2,30.3]

Required:

1. Estimate a and b using a non-linear fitting technique.
2. Display the original data points and the fitted curve.

Task 4: Laws Containing Three Constants.

Fit the model y= a + b*ln(x) + cx^2 to the data: x=[1,2,3,4,5] y=[2.1,3.6,6.3,11.5,18.9]

Required:

1. Compute the constants a,b,c.
2. Plot the fitted curve and the original data.

Part 2: Finite Differences

Task 5: Forward Difference Table.
Construct a forward difference table for the following data: x=[0,1,2,3,4]
y=[1,3,7,13,21]

Required:

1. Show the forward difference table.
2. Verify that the third-order differences are constant.

Task 6: Backward Difference Table.
Construct a backward difference table for the following data: x=[5,6,7,8,9]
y=[1,8,27,64,125]

Required:

1. Show the backward difference table.
2. Verify that the second-order differences are constant.

Task 7: Higher-Order Differences.
For the data: x=[0,1,2,3,4] y=[1,8,27,64,125]
Compute and verify the fourth forward difference.

Required:

1. Compute the forward difference table.
2. Highlight and interpret the fourth forward difference value.