Practice Questions – Class 01: Introduction to Machine Learning

A. Theoretical Questions

1. In your own words, explain the statement: "Machine Learning is all about prediction." Give two real-life examples similar to weather forecast or stock price prediction.

2. What is the main goal in Machine Learning according to the slides: to calculate the exact value or to predict (guess) the value? Why is this distinction important?

3. For the apple price example, the points lie on a perfect straight line. For the mango price example, they do not.
   (a) How does this difference affect the way we predict the Day-06 price?
   (b) Why can't we directly calculate the exact line for mango prices using a simple two-point formula?

4. Define the following terms clearly and explain how they are related:
   (a) Loss function
   (b) Cost function
Which one tells you the overall performance of a model on the whole dataset, and why?

5. What is meant by a "best-fit line" or "regression line"? Why is it important to find such a line for prediction in regression problems?

6. The slides mention that "we can guess infinite values and draw infinite lines" for the mango data.
   (a) What condition do we use to choose the best line among these infinite possibilities?
   (b) How is this condition connected to minimizing prediction error?

7. Briefly describe the three main types of learning:
   • Supervised learning
   • Unsupervised learning
   • Reinforcement learning
For each type, give one example related to daily life or robotics.

8. Explain the core idea of the Gradient Descent algorithm. Describe the four high-level steps, and say why we move "downhill" on the cost function.

9. Compare the Numerical Analysis (least squares) method and Gradient Descent for finding the best-fit line. In which situation might Gradient Descent be more practical than the closed-form numerical method?

B. Mathematical Practice Questions

Question 1 – Straight-line prediction.

Consider the following perfectly linear data for the price (in tk) of 1 kg of a fruit over 5 days:

Day (x)	Price (y) in tk
1	120
2	150
3	180
4	210
5	240

1. Using any two points from the table, calculate the slope m of the straight line using:
   $m = (y_2 - y_1) / (x_2 - x_1)$.

2. Use one of the points and the value of m to find the intercept b from:
   $b = y_1 - m\, x_1$.

3. Write the final equation of the line in the form $y = mx + b$.

4. Using this equation, predict the price on Day 7.

Question 2 – Best-fit line with non-linear data.

You are given the price (in tk) of 1 kg of mango over 5 days:

Day (x)	Price (y) in tk
1	60
2	45
3	85
4	62
5	110

1. Using the least squares (numerical analysis) formulas for simple linear regression, compute:
   (a) The slope m
   (b) The intercept b
so that the line $y = mx + b$ best fits the above data.

2. With your values of m and b, predict the mango price on Day 6.

3. Suppose the actual price on Day 6 turns out to be 115 tk.

(a) Compute the prediction error (|actual − predicted|).

(b) If we define the loss for this single example as the squared error, write the value of this loss.