Vidyavardhini's College of Engineering and Technology, Vasai (West)

First Year Engineering
Academic Year: 2024-2025
Assignment Test-1: Solutions

Subject/Code: Elective Physics/BSC2023 **Date: 10/01/2025**
Max Marks: 10 **Duration: 1 Hr**

CO1: To provide students with a basic understanding of measurements in the field of basic engineering.
CO2: To explain the basic importance of interference in the field of measurements.

Q2. Problem Statement

A small population of $N = 8$ students scored the following marks in a physics test: $75, 80, 82, 70, 85, 90, 88, 76$. Calculate the population mean and population standard deviation.

Solution

1. Population mean for 8 batches:

$$\mu = \frac{\sum x}{N} = \frac{75 + 80 + 82 + 70 + 85 + 90 + 88 + 76}{8} = \frac{646}{8} = 80.75 \quad \text{Marks}$$

2. Standard Deviation:

$$\sigma = \sqrt{41.1875} \approx 6.42 \quad \text{Marks}$$

Q4. Problem Statement

In an experiment to study Newton's second law of motion, the force F and acceleration a values are recorded as follows:

Acceleration a (m/s^2)	Force F (N)
0.5	2.5
1.0	4.8
1.5	7.3
2.0	9.7
2.5	12.1

We assume the relationship:

$$F = ma + c$$

where m is the mass and c is a correction factor. Using the least squares method, we determine the best-fit values of m and c.

Solution

The least squares method minimizes the error function:

$$E(m, c) = \sum_{i=1}^{n} (F_i - (ma_i + c))^2$$

where $n = 5$ is the number of data points.
The normal equations for least squares fitting are:

$$\sum F_i = m \sum a_i + nc \tag{1}$$

$$\sum (F_i a_i) = m \sum (a_i^2) + c \sum a_i \tag{2}$$

Computing the summations:

$$\sum a_i = 0.5 + 1.0 + 1.5 + 2.0 + 2.5 = 7.5,$$
$$\sum F_i = 2.5 + 4.8 + 7.3 + 9.7 + 12.1 = 36.4,$$
$$\sum a_i^2 = (0.5)^2 + (1.0)^2 + (1.5)^2 + (2.0)^2 + (2.5)^2 = 13.75,$$
$$\sum (F_i a_i) = (0.5 \times 2.5) + (1.0 \times 4.8) + (1.5 \times 7.3) + (2.0 \times 9.7) + (2.5 \times 12.1) = 66.65.$$

Substituting into the normal equations:

$$36.4 = 7.5m + 5c \tag{3}$$

$$66.65 = 13.75m + 7.5c \tag{4}$$

Solving for m and c:

$$m = 241/50 = 4.82 \quad \text{kg}, \quad c = 1/20 = 0.05 \quad \text{N}$$

Thus, the best-fit equation is:

$$F = 4.82a + 0.05$$