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

First Year Engineering

Academic Year: 2024-2025

Surprise Test: CO1 and CO2

Subject: BSC2023/EP **Date: 18/02/2025**
Max Marks: 10 **Duration: 15 mins**

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

Instructions
1. All questions are compulsory
2. Each question carries equal weight-age of 2 marks each
3. Marks will be given as per the depth of the answer, not length.

Q1: A researcher collects data on the heights (in cm) and weights (in kg) of 12 students:

Height (cm)	Weight (kg)
150	45
155	50
160	54
162	57
165	60
168	63
170	66
172	68
175	72
178	75
180	78
185	82

1. Calculate the sample and population mean for both height and weight.
2. Compute the population and sample standard deviation for both height and weight.
3. Fit a straight line using the principle of least squares for the given data, assuming the equation $y = a + bx$, where x represents height and y represents weight.
4. Predict the weight of a student whose height is 190 cm using the obtained equation.

Q2: A light beam of wavelength $650\,nm$ is used in an interferometry test for detecting a surface defect. If the path difference is $1.3\,\mu m$, what type of interference will occur?

Solution to Q1

1. Sample and Population Mean

The mean is given by:

$$\mu = \frac{\sum x_i}{N}, \quad \bar{x} = \frac{\sum x_i}{n} \tag{1}$$

where N is the population size and n is the sample size.

For height:

$$\mu_{height} = \frac{150 + 155 + \cdots + 185}{12} = 168.33 \text{ cm} \tag{2}$$

For weight:

$$\mu_{weight} = \frac{45 + 50 + \cdots + 82}{12} = 64.17 \text{ kg} \tag{3}$$

2. Sample and Population Standard Deviation

Standard deviation is computed as:

$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}} \tag{4}$$

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} \tag{5}$$

After computation:

$$\sigma_{height} = 10.01 \text{ cm}, \quad s_{height} = 10.45 \text{ cm} \tag{6}$$

$$\sigma_{weight} = 10.98 \text{ kg}, \quad s_{weight} = 11.47 \text{ kg} \tag{7}$$

4. Least Squares Method

We assume:

$$y = a + bx \tag{8}$$

Using least squares estimation formulas:

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}, \quad a = \frac{\sum y - b\sum x}{n} \tag{9}$$

After solving,

$$b = 1.09534 \approx 1.1, \quad a = -120.21619 \approx -120.2 \tag{10}$$

Thus, the equation is: $y = -120.2 + 1.1x$

5. Prediction

For $x = 190$:

$$y = -120.2 + 1.1(190) = 88.8 \text{ kg} \tag{11}$$

Thus, the predicted weight for a student with height 190 cm is 88.8 kg.

Solution to Q2: (a), as $\Delta h = m\lambda$ for constructive interference.