ELECTRONIC MEASUREMENT & INSTRUMENTATION (BEC-29)

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UNIT-1
Lecture 3 & 4

Qualities, Measurements and Digital Display Devices

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Lecture 5 & 6:

- Limiting Errors
- LED

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- LCD
- Incandescent Display

Lecture 8:

- LVD
- Printers

Lecture 9:

- Digital voltmeters
- Spectrum analyzer

Statistical Analysis of Error

Arithmetic Mean:

- The most probable value of a measured value is the arithmetic mean of readings taken.
- The arithmetic mean of n measurements at a specific count a variable x is given by the expression:

$$\bar{x} = \frac{x1+x2+x3-----xn}{n}$$

$\bar{x}$ = arithmetic mean

n = no of readings

x_n = nth reading taken

Deviation from the Mean Value: This is the departure of the given reading from the arithmetic mean of readings. If the deviation of the first reading, x1, called deviation d1 and second reading x2 called d2 and so on.

The deviation from the mean is expressed as:

- d1 = x1- $\bar{x}$, d2 = x2 - $\bar{x}$ and so on.
- The deviation may be positive or negative.
- The algebraic sum of all the deviations must be zero.

Average Deviation: is an indication of the precision of instrument used in the measurement.

- It is defined as the sum of the absolute values of the deviation divided by the no. of the readings. The absolute value is the independent of the sign.
- Dav= $\frac{d1+d2+d3-----dn}{n}$
- Dav = average deviation
- $d1, d2, d3 ---- -dn$ = absolute value of deviation
- N = no of readings

Standard Deviation: is the square root of sum of all individual deviations squared, divided by the number of readings.

- $\sigma = \sqrt{\frac{d1^2 + d2^2 + \ldots\ldots dn^2}{n}}$ where σ = standard deviation
- It is also known as root mean square deviation and is the most important parameter in statistical analysis of measured data.

Limiting Errors: Most manufacturers of measuring measurement specify accuracy within % of full-scale reading. This specification is called the limiting error. For ex- manufacturer of a certain voltmeter may specify the instrument to be accurate within $\pm 2\%$ of the full-scale reading.

Assignment Questions

- What are limiting errors? What is the significance of limiting errors?
- Define the following terms:
  1. Average value
  2. Arithmetic mean
  3. Deviation
  4. Standard deviation
- What is the difference between average deviation and standard deviation?

Practice Problems

- The accuracies of five precision resistances are checked by comparing them with 1.000 Ω resistor. The measured resistances are as follows: R1= 1.001Ω , R2 = 1.002 Ω , R3= 0.999 Ω, R4 = 0.998 Ω and R5 = 1.000 Ω. Calculate the average resistance and measured deviation.
- Determine the standard deviation and probable measurement error for the group of resistors defined above.
- The output voltage from a precision 12V power supply, monitored at intervals over a period of time, produced the following readings: V1= 12.001V, V2 =11.999V, V3= 11.998V, V4= 12.003V, V5=12.002V and V6 = 11.997V, V7= 12.002V, V8= 12.003V, V9=11.998V and V10=11.997V. Calculate:
- Average voltage level
- The mean deviation
- Standard deviation
- Probable error in the measured voltage at any time.

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- A sample group taken from a batch of resistors give the following results:R1= 100.06 Ω, R2 = 100.03 Ω, R3 = 100.04 Ω, R4= 100.08 Ω, R5= 100.06 Ω, R6= 100.07 Ω, R7 =99. 05 Ω, R8= 99.04 Ω, R9= 99.02 Ω, R10= 100.04 Ω, R11= 100.03 Ω, R12= 99.04 Ω, R13= 99.07 Ω, R14=99.06 Ω and R15= 99.03 Ω. The errors are assumed to be random. Specify the mean value of the resistors and the tolerance if approximately 95% of the components are to be within the tolerance limits.

THANK YOU