ELECTRONIC MEASUREMENT & INSTRUMENTATION (BEC-29)

Instructor

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August, 2020

UNIT-1
Lecture 1

Qualities, Measurements and Digital Display Devices

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- Limiting Errors
- LED

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- LCD
- Incandescent Display

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- Digital voltmeters
- Spectrum analyzer

Performance Characteristics of Instruments

- It is classified as: **Static** and **Dynamic**.
- **Static characteristics** are considered for instruments which are used to measure an unvarying process condition. These characteristics are obtained by a process called calibration.
- The **Static characteristics** have following parameters:
  - **Accuracy**: the degree of exactness of a measurement to a compared to a expected value.
  - **Resolution**: the smallest change in the measured value to which a instrument will respond.
  - **Precision**: a measure of consistency or repeatability of measurement i.e. successive values do not differ.
  - **Sensitivity**: the ratio of change in output of the instrument to a change in the input or measured value.
  - **Expected value**: the design value, i.e. the most probable value the calculations indicate one should expect to measure.
  - **Error** : the deviation of true value from the desired value.

Dynamic Characteristics

- Is determined by subjecting its primary element to some unknown and predetermined variations in the measured quantity.
- The three most common variations are : step change, linear change and sinusoidal change.
- The dynamic characteristics are:
  - **Speed-** rapidity with which the instrument responds to change in measured quantity.
  - **Fidelity-** degree to which instrument indicates the change in measured quantity without any dynamic error.
  - **Lag-** delay in response of instrument with respect to the measured variable.
  - **Dynamic error** – difference between the true value of the quantity changing in time and the value indicated by the instrument, if no static error is assumed.

Sources of Error

The sources of error other than a piece of inability of hardware is to provide a true measurement are:

- Insufficient knowledge of design conditions and process parameters.
- Poor design.
- Poor Maintenance.
- Error caused by person operating the instrument.
- Certain design limitations.

Error in Measurements

- Measurement is the process of comparing an unknown quantity to an accepted standard quantity.
- The measurement is a quantitative measure of so called “True Value”.
- Some factors that affect the measurement are related to the measuring instrument itself. Other factors are related to person using the instrument.
- Error can be measured as absolute or percentage of error.
  - Absolute error is defined as the difference between the expected value of the variable and measured value of the variable.
  - E = Yn – Xn
  - Where, E = absolute error
  - Yn= expected value
  - Xn= measured value
  - Percentage of error = $\left(\frac{E}{Yn}\right) * 100$; $\frac{Yn - Xn}{Yn}$
  - It is expressed as accuracy rather than error.
  - Relative accuracy A= $\left(1 - \frac{Yn - Xn}{Yn}\right)$
  - Accuracy is expressed as percentage accuracy a = 100% - % error
  - a= A* 100%

Assignment Questions

- What do you understand by static characteristics?
- Define the terms : resolution, sensitivity and expected value.
- Define the terms : instrument, accuracy, precision and errors.
- Explain the gross error in detail. How it can be minimized?
- Explain systematic error in detail. How I can be minimized?

Conceptual Questions

- The closeness of value indicated by an instrument to the actual value is defined as

  (a) Repeatability (b) reliability (c) uncertainty (d) accuracy
- Precision is defined as

  (a) Repeatability (b) reliability (c) uncertainty (d) accuracy
- The ratio of change in output to the change in input is defined as

  (a) Precision (b) resolution (c) sensitivity (d) repeatability
- The deviation of the measured value to the desired value is defined as

  (a) Error (b) repeatability (c) hysteresis (d) resolution
- Accuracy can be defined as

  (a) Relative accuracy (b) % accuracy (c) error (d) % error

Practice Problems

- A batch of 3.3 KΩ resistors is measured as 3.5K Ω maximum and 3.1 KΩ minimum. Specify the resistor tolerance, and the maximum absolute and relative errors.
- A 5 KΩ potentiometer with a 25 Ω resolution is used as a voltage divider. If the potentiometer supply is 12V, determine the precision of the output voltage.
- Calculate the maximum percentage error in the sum of two voltage measurements when V1= 100V $\pm 1\%$ and V2 = 80V $\pm$ 5 %.
- Calculate the maximum percentage error in the difference of two voltage measurements when V1= 100V $\pm 1\%$ and V2 = 80V $\pm$ 5 %.

THANK YOU