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DEPARTMENT OF BIOMEDICAL ENGINEERING

III Semester- BM3301 SENSORS AND MEASUREMENTS

UNIT -1

1.8 Calibration – Primary and Secondary Standards

1.8.1 Static Calibration:

All the static performance characteristics are obtained in one form or another by a process called static calibration. The calibration of all instruments is important since it affords the opportunity to check the instrument against a known standard and subsequently to find errors and accuracy.

Calibration procedures involve a comparison of the particular instrument with either (1) a primary standard, (2) a secondary standard with a higher accuracy than the instruments be calibrated, or (3) an instrument of known accuracy.

Actually, all working instruments, i.e., those instruments which are actually used for measurement work must be calibrated against some reference instruments which have a higher accuracy. Thus, reference instruments in turn must be calibrated against instrument of still higher grade of accuracy, or against primary standard, or against other standards of known accuracy. It is essential that any measurement made must ultimately be traceable to the relevant primary standards.

1.8.2 The need for calibration:

Measurement is vital in science, industry and commerce. Measurement is also performed extensively in our daily life. The following are some examples:

- Measurements for health care, such as measuring body temperature with a clinical thermometer, checking blood pressure and many other tests;

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- Checking the time of day;
- Buying cloth for dresses;
- Purchase of vegetables and other groceries;
- Billing of power consumption through an energy meter.

Accuracy and reliability of all such measurements would be doubtful if the instruments used were not calibrated. Calibration ensures that a measuring instrument displays an accurate and reliable value of the quantity being measured. Thus, calibration is an essential activity in any measurement process.

1.8.3. What is calibration?

According to the International Organization for Standardization publication entitled International Vocabulary of Basic and General Terms in Metrology (published in 1993 and known as VIM), calibration is the set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument, a measuring system or values represented by a material measure, and the corresponding known values of a measurand (the parameter that is being measured; see also chapter 9 below for a fuller explanation of the term “measurand”). Understanding of calibration is not complete without understanding traceability. In the above definition, the known values of the measurand refer to a standard. This standard must have a relationship vis-à-vis the calibration.

> ***Traceability:*** *The concept of establishing valid calibration of a measuring standard or instrument by step-by-step comparison with better standards up to an accepted national or international standard. Essentially, calibration is a comparison with a higher standard that can be traced to a national or international standard or an acceptable alternative.*

1.8.4 Periodicity of calibration:

Periodicity of calibration generally would be finalized based on recorded investigation. This means that calibration results of an instrument must be monitored over time and, depending on the drift it exhibits, the time period between recalibration can be decided. However, this is possible only after a few recalibrations. How should

the initial recalibration interval be fixed? The initial decision to determine the calibration interval is based on the following factors:

- Recommendation of the instrument manufacturer;
- How frequently and severely the instrument is expected to be used;
- The influence of the environment;
- Maximum allowable variation of the measurand;
- The uncertainty of measurement required.

Such a decision should, however, be made by a person with experience of measurement and who is knowledgeable about calibration of the instrument. This experience and knowledge would help in estimating the length of time an instrument is likely to remain within tolerance after calibration. However, clearly there cannot be one universal method of determining the calibration periodicity for all types of measuring instruments.

1.8.5 Primary Standards:

- Primary standards are absolute standards of such high accuracy that they can be used as the ultimate reference standards.
- These standards are maintained by national standards laboratories in different parts of the world. The primary standards, which represent the fundamental units and some of the derived electrical and mechanical units, are independently calibrated by absolute measurements at each of the national laboratories.
- The results of these measurements are compared against each other, leading to a world average figure for the primary standards.
- Primary standards are not available for use outside the national laboratories. One of the main functions of the primary standards is the verifications and calibration of secondary standards.
- The primary standards are few in number. They must have the highest possible accuracy. Also, these standards must have the highest stability, i.e., their values should vary as small as possible over long periods of time even if there are environmental and other changes.
- In the recent past, the techniques of establishing primary standards have been drastically refined so that accuracy attainable has become of a very high level.

1.8.6 Secondary Standards:

- The secondary standards are the basic reference standards used in industrial measurement laboratories.
- The responsibility of maintenance and calibration of these standards lies with the particular industry involved.
- These standards are checked locally against reference standards available in the area. Secondary standards are normally sent periodically to the national standards laboratories for calibration and comparison against primary standards.
- The secondary standards are sent back to the industry by the national laboratories with a certification as regards their measured values in terms of primary standards.

Example:

Two type of transduction occurs in the Bourdon's tube. First, the pressure is converted into a displacement and then it is converted into the voltage by the help of the L.V.D.T. The Bourdon's Tube is the primary transducer, and the L.V.D.T is called the secondary transducer.

1.8.7 Applications of Sensor Calibration:

1. The calibration process is used to increase the performance and functionality of the system.
2. It helps in reducing errors in the system. A calibrated sensor provides accurate results and can be used as a reference reading for comparison.
3. With the increase in the embedded technology and low size of sensors, many sensors are integrated over a single chip. Undetected errors in one sensor can cause the whole system to degrade. It is important to calibrate the sensor to get the accurate performance of the automated systems.

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