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BASICS OF TRANSDUCER

Instrumentation engineering is the branch of engineering that specialize on the principle and operation of measuring instrument that are used in field of design, configuration of automated system is electrical pneumatic domains etc.

Typical Applications of Instrument Systems

The objective of performing experiments are too numerous to be enumerated. However, certain common motivating factors for carrying out the measurements are as follows:

(1) *Measurement of system parameter information*

One of the important functions of the instruments is to determine the various parameters/information of the system or a process.

(2) *Control of a certain process or operation*

Another important application of measuring instrument in the field or automatic control system.

(3) *Simulation of system conditions*

Sometimes, it may be necessary to simulate experimentally the actual conditions of complex situations for revealing the true behavior of the system under different governing conditions.

(4) *Experimental design studies.*

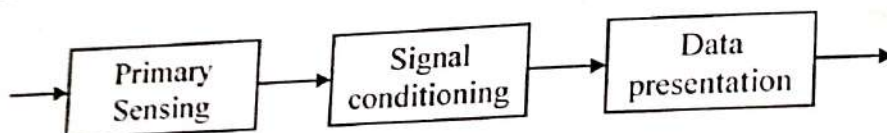
The design and development of a new product generally involves trial and error produces which generally involve the use of empirical relations, handbook data, the standard practices mentioned in design codes as well as design equations based on scientific theories and principles.

(5) *To perform various manipulations*

A simple pocket calculator is an example of a mathematical processing instrument, to some extent. Further, the modern large-memory computers are instruments that are capable of varied types of mathematical manipulations.

- (6) **Testing of materials, maintenance of standards and specifications of products**
Most countries have standards organizations that specify material standards and product specifications based on extensive tests and measurements.
- (7) **Quality control in industry**
It is quite common these days to have continuous quality control tests of mass produced industrial products. This enables to discover defective components that are outright rejected at early stages of production. Consequently, the final assembly of the machine/system is free from defects.

Basic Functional Element of a Measurement system



Primary Sensing Element

- The quantity under measurement makes its first contact with the primary sensing element of the measurement system. In other words, the measurand is first detected by the primary sensor. This act is immediately followed by the conversion of the measurand into an analogous electrical signal. This is done by the transducer.
- A transducer, in general, is defined as a device which converts energy from one form to another.
- The first stage of a measurement system is known as a detector transducer stage.

Signal conditioning element

Variable Conversion Element

- The output of the primary sensing element may be an electrical signal of any form. It may be a voltage, frequency, or some other electrical parameter. Sometimes this output is not suited to the system. For the instrument to perform the desired function, it may be necessary to convert this output to some other suitable form while preserving the information content of the original signal.

Variable Manipulation Element

- The function of this element is to manipulate the signal presented to it while preserving the original nature of the signal. Manipulation here means only a change in the numerical value of the signal. For example, an electronic amplifier accepts a small voltage signal as input and produces an output signal which is also a voltage but of greater magnitude. Thus, a voltage amplifier acts as a variable manipulation element.

Types of Transducer

The information about the quantity under measurement has to be employed to the personnel handling the equipment in the system for monitoring, control, or analysis purposes.

Types of Transducer and their modes of operation

| Type | Operation |
|---------------------------------------|----------------------------------|
| 1. Variable capacitance, piezo effect | Displacement to displacement |
| 2. Piezoelectric | Force to displacement |
| 3. Potentiometer | Pressure to displacement |
| 4. Potentiometer | Pressure to displacement |
| 5. Potentiometer | Pressure to displacement |
| 6. Potentiometer | Force to displacement |
| 7. Mass | Forcing function to displacement |
| 8. Pendulum scale | Force to displacement |
| 9. Manometer | Pressure to displacement |
| 10. Thermal | Temperature to electric current |
| 11. Thermocouple | Temperature to displacement |
| 12. Bimaterial | Temperature to phase |
| 13. Temp-stick | |
| 14. Hydro pneumatic | |
| 15. Static | Fluid level to displacement |
| (a) Float | Specific gravity to displacement |
| (b) Hydrometer | |
| 16. Dynamic | |
| (a) Orifice | Velocity to pressure |
| (b) Venturi | Velocity to pressure |
| (c) Pitot tube | Velocity to pressure |
| (d) Vanes | Velocity to force |
| (e) Turbines | Linear to angular velocity |

Transducers

An electronic instrumentation system consists of a number of components to perform a measurement and record its results. As explained earlier a generalized measurement system consists of three major components.

- an input device
- a signal conditioning or processing device,
- an output device

Electric Transducers

The first stage of measurement system may simply be called a *transducer stage* instead of *detector transducer stage* by redefining a transducer. A transducer, in general from, may be defined as a device which converts energy from one form to another. However, this definition has to be restricted, many a time especially in the field of *electrical instrumentation*. Keeping this restriction in view, a *transducer* may be defined as a device which converts a physical quantity or a physical condition into an electrical signal. Another name of a transducer is *pick up*.

When the definition of *transducer* is confined to a device that covers the entire *detector transducer stage* wherein the transducer converts a non-electrical quantity into an analogous electrical signal, the transducer may be thought of consisting of two important and closely related parts. These two parts are:

(i) Sensing Element, and (ii) Transduction Element

1. **Sensing or Detector Element.** A detector or a sensing element is that part of a transducer which responds to a physical phenomenon or a change in a physical phenomenon. The response of the sensing element must be closely related to the physical phenomenon.
2. **Transduction element.** A transduction element transforms the output of a sensing element into an electrical output. The *transduction element*, in a way, acts as a *secondary transducer*.

Classification of Transducers

The transducers can be classified

- (i) on the basis of transduction form used,
- (ii) as primary and secondary transducers,
- (iii) as passive and active transducers,
- (iv) as analog and digital transducers,
- (v) as transducers and inverse transducers

1. Classification based upon Principle of Transduction

The transducers can be classified on the basis principle of transduction as resistive, inductive, capacitive etc. depending upon how they convert the input quantity into resistance, inductance, capacitance respectively.

2. Primary and Secondary Transducer.

Let us consider the case of a Bourdon's tube. The Bourdon tube acting as a primary detector senses the pressure and converts the pressure into a displacement of its free end. The displacement of the free end moves the core of a linear variable differential transformer (L.V.D.T.) which produces an output voltage which is proportional to the movement of the core, which is proportional to the displacement of the free end which in turn is proportional to the pressure. Thus, there are two stages of transduction, firstly the pressure is converted into a displacement by Bourdon tube then the displacement is converted into an analogous voltage by L.V.D.T. The Bourdon tube is called a "Primary Transducer" while the L.V.D.T. is called a "Secondary Transducer".