UNIT-V

TRANSDUCER AND DATA ACQUISITION SYSTEM

1. Define transducer.

   It is a device which converts one form of energy into another form.

2. What are the classification of transducer? The transducers are classified as
   a. According to the transduction principle
   b. Primary and secondary transducer
   c. Active and passive transducer
   d. Analog and digital transducer
   e. Transducer and inverse transducer

3. Define active transducer.

   Active transducers are self generating type of transducers. These transducers develop an electrical parameter which is proportional to the input quantity.

4. Define passive transducer.

   Passive transducer do not generate any electrical signal themselves. To obtain an electrical signal from such transducers, an external source of power is essential.

5. What is analog transducer?

   Analog transducer converts input signal in to output signal, which is a continuous function of time such as strain gauge, LVDT, thermocouple.

6. What is digital transducer?

   Digital transducer converts input signal in to the output signal, which is in the form of pulses.

7. What is an inverse transducer?

   An inverse transducer is defined as a device which converts an electrical quantity in to a non electrical quantity.

8. Write the transducer selection factor.
   a. Nature of measurement
   b. Loading effect
   c. Environmental conditions
   d. Measuring system compatibility
   e. Cost and availability.

9. Define strain gauges.

   The strain gauge is an example of a passive transducer that uses the variation in electrical resistance in wires to sense the strain produced by a force on the wire.

10. Define gauge factor.

The gauge factor is defined as the ratio of per unit change in resistance to per unit change in length.

$$\text{Gauge factor} : \frac{\Delta R/R}{\Delta L/L}$$

11. What are the main types of potentiometers?
    a. Wire wound potentiometer
    b. Non wire potentiometers

12. Mention the types of strain gauges

The strain gauges are mainly of four types namely
    a. Wire strain gauges
    b. Foil strain gauges
    c. Thin film strain gauge
    d. Semiconductor strain gauge.

13. What is an inductive transducer?

An inductive transducer is a device that converts physical motion in to a change in inductance. Transducers on the variable inductance type work upon one of the following principles.
    a. Number of turns
    b. Geometric configuration
    c. Permeability of the magnetic material

14. Mention the advantages of LVDT
    a. LVDT has high sensitivity.
    b. The LVDT gives a high output.

15. Mention the applications of LVDT.

LVDT are used to measure
    a. Displacement
    b. Force
    c. Weight
    d. Pressure
    e. Position

16. What are the types of DAS?

The DAS is mainly classified as
    a. Analog data acquisition system (DAS).
    b. Digital data acquisition system (DAS).

17. What is piezoelectric effect?

A piezoelectric material is one in which an electric potential appears across certain surfaces of a crystal if the dimensions of the crystal are changed by the application of a mechanical force. This potential is produced by the displacement of charges. The effect is reversible also if varying potential is applied to the proper axis of the crystal, it will change the dimensions of the crystal there by deforming it. This phenomenon is known as piezoelectric effect.

18. What are the materials used for piezoelectric transducers?

Common piezoelectric materials include ammonium dihydrogen phosphate , quartz and ceramics made with barium titanate, potassium dihydrogen phosphate and lithium sulphate are used in real applications.

19. Define smart sensor?

Smart sensors are sensors with integrated electronics that can perform one or more of the following functions.

a. Logic functions
b. Two way communication
c. Make decision

20. Mention some applications of smart sensor.

Smart sensor enhances the following applications:

a. Self calibration
b. Computation
c. Communication

UNIT-IV

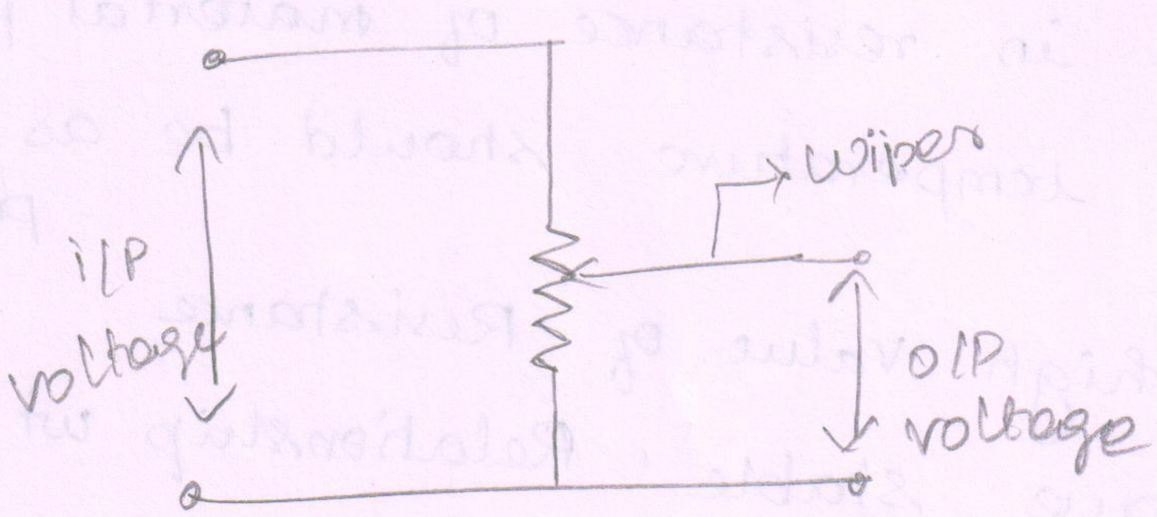
1. [redacted] of Transducer:-

1. Ruggedness
2. Linearity
3. Repeatability
4. High O/P signal Quality
5. High Reliability & Stability
6. Good dynamic Response
7. No Hysteresis
8. Residual Deformation.

2. Selection of Transducers:-

1. Operating Range
2. Sensitiviby
3. Electrical O/P characteristics
4. Environmental Conditions
5. Errors.
6. Accuracy.

3. Resistive transducer:-



→ Resistance changes due to a change in some physical phenomenon.

$$R = \rho \frac{l}{a}$$

ρ - resistivity of material in Ωm

l - length of conductor in metres

a - cross-sectional area of conductor in m^2.

$$e_o = \left[\frac{\text{Resistance at o/p terminals}}{\text{Resistance at i/p terminals}}\right] \times \text{i/p voltage}$$

$$= \frac{R_p\,[x_i/x_t]}{R_p} \times e_i$$

$$\boxed{e_o = \frac{x_i}{x_t} \times e_i}$$

$$\text{Sensitivity} \quad S = \frac{\text{O/P}}{\text{I/P}} = \frac{e_o}{x_i} = \frac{e_i}{x_t}$$

$$e_o = e_i \left[\frac{\theta_i}{\theta_t}\right]$$

4) Resistance thermometer :-

1) The change in resistance of material per unit change in temperature should be as large as possible.

2) Material - high value of Resistance

3) Should have stable Relationship with temperature.

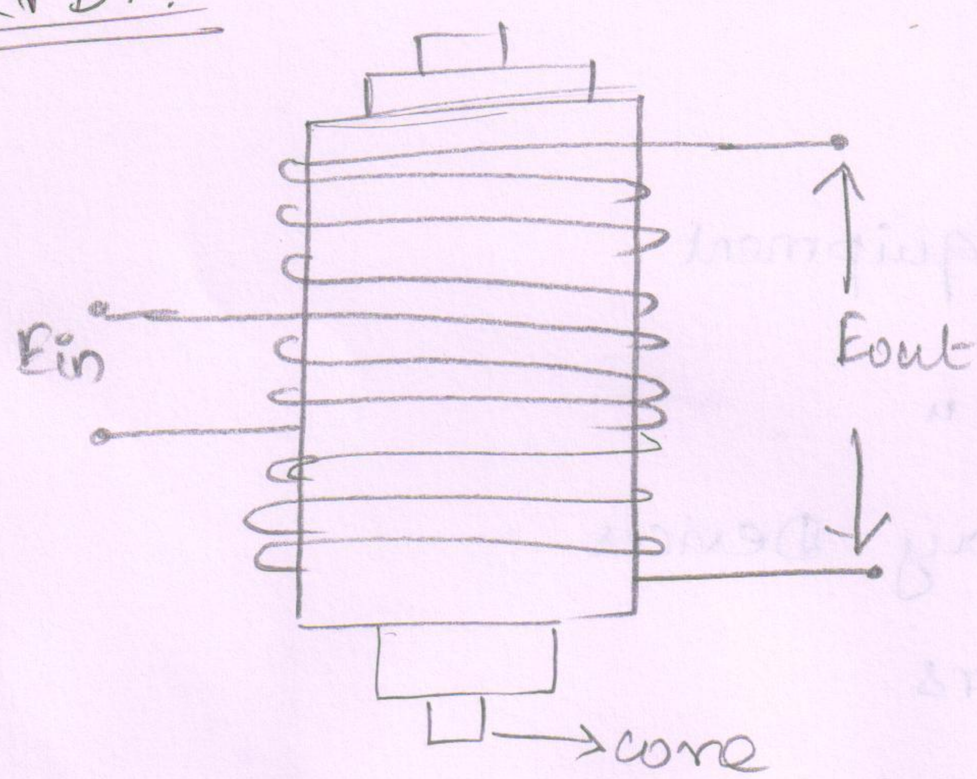
Diagram - 4M

→ External voltage source is required.

→ Wheatstone bridges are usually employed for the measurement of variation in resistance.

→ Applicable to measurement of small resistance.

5) LVDT :-



→ primary(P) secondary winding S_1, S_2

→ converts linear motion into electrical signals.

→ P is connected to Ein - 5 - 25V with 50Hz to 20kHz.

→ O/P voltage ES_1, ES_2 are induced

→ S_1 S_2 are connected in series to convert $S_1 \rightarrow S_2$ (voltage)

$$E_0 = E_{S1} - E_{S2}$$

case 1: NULL

case 2: $E_0 = E_{S1} - E_{S2}$ (left)

case 3: $E_0 = E_{S2} - E_{S1}$ (right)

Data Acquisition System:-

1. Analog
2. Digital

Basic Elements - Analog:-

1. Transducer
2. Signal Conditioner
3. Multiplexing
4. Calibrating Equipment
5. Integrating "
6. Visual Display Devices
7. Analog Recorders
8. Analog Computers
9. High speed Cameras & T.V.

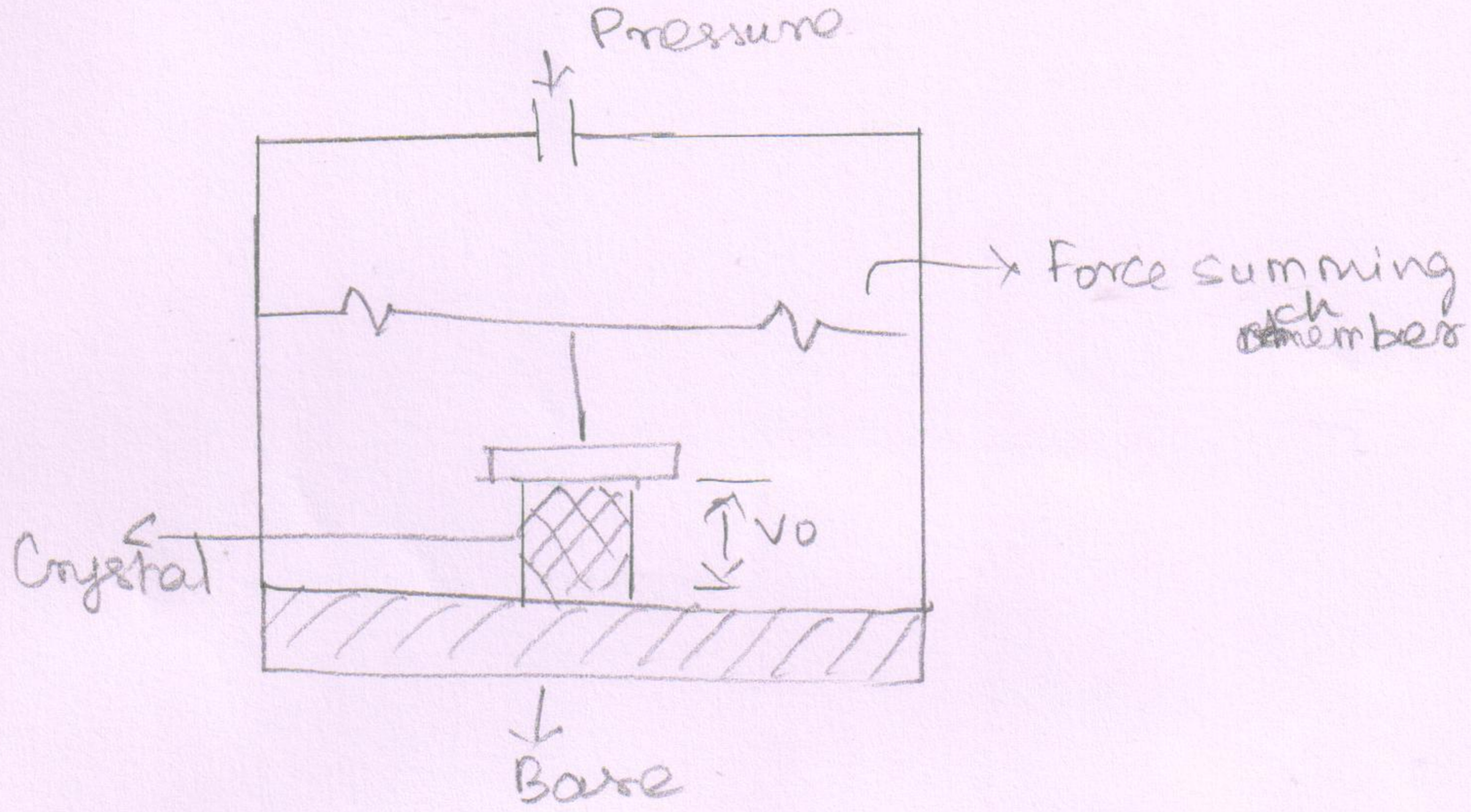
Digital DAS:-

Diagram - 4M

1. Transducer
2. Signal Conditioner
3. Multiplexer
4. Signal Converter
5. ADC
6. Auxiliary Equipments
7. Digital Recorders.

Piezo electric Transducer:-

When electric potential appears across any two opposite phase of crystal, it vibrates. (or) vice-versa.



$$Q = F \times d$$

$$F = \frac{AE}{t} \cdot \Delta t$$

$$E_o = \frac{Q}{C_p}$$

$$\boxed{g = \frac{E_o}{t.P} = \frac{E_o/t}{P}}$$