ELECTRONIC MEASUREMENT & INSTRUMENTATION (BEC-29)

Instructor

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UNIT- 2

Lecture-4 & 5

Transducers

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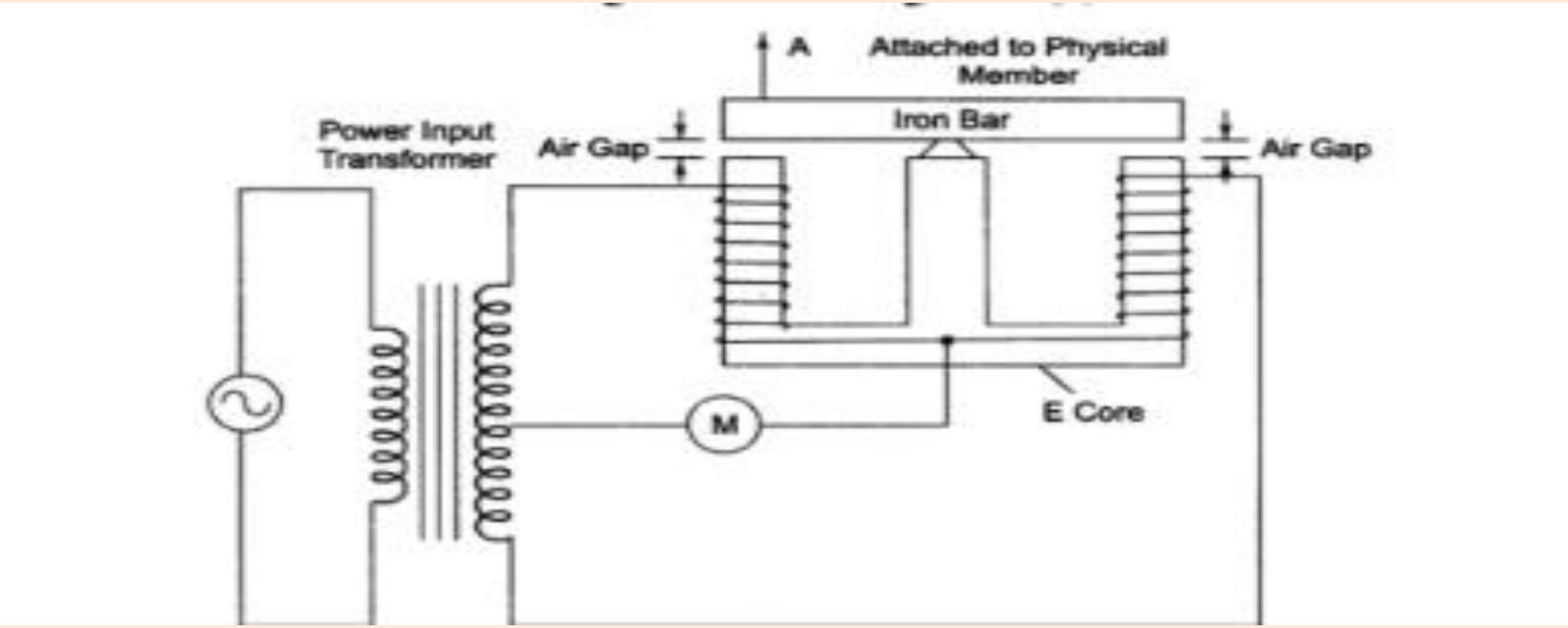
Inductive Transducer

- Inductive transducers may be either be self generating or passive type. The self generating type works on the basic electrical generator principle: relative motion between a conductor and magnetic field induces a voltage in the magnetic field.
- Since it is the displacement which changes the length of the air-gap, the self inductance is a function of displacement.



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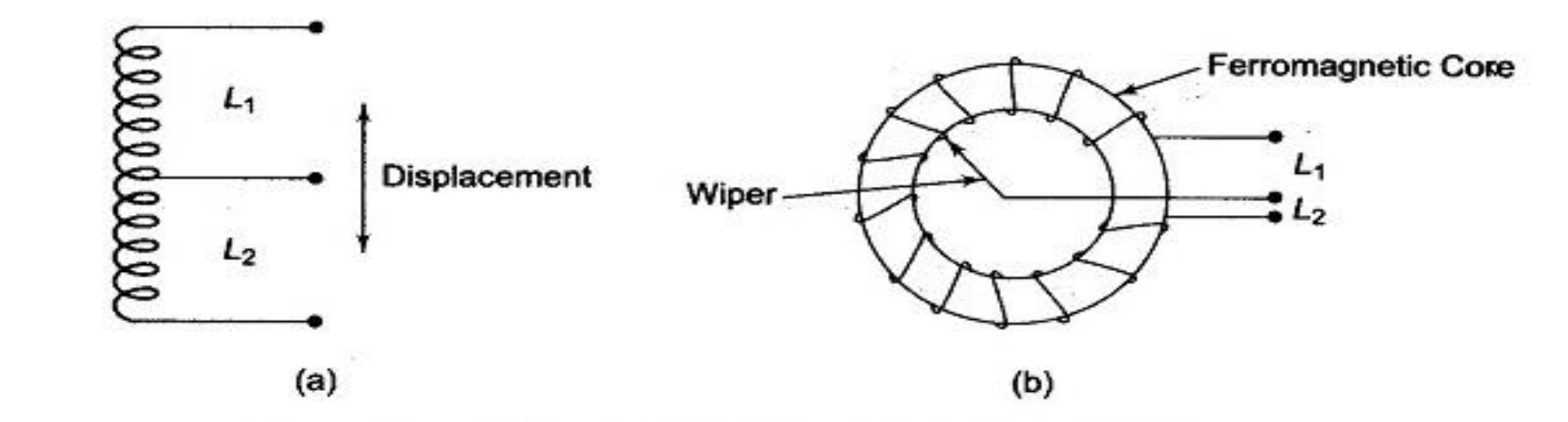
- A separate coil is wound on each outside leg of an E core and an iron bar is pivoted on the center leg. A magnet extends from each outside leg through an air gap and through the iron bar to the center leg.
- The moving member is attached to one end of the iron bar and causes the bar to wobble back and forth, thereby varying the size of each air gap.
- The bridge consists of two transducer coils and a tapped secondary of the input power transformers. It is balanced only when the inductance of the two transducer coils are equal, i.e. when the iron bar is in nearly exact horizontal position and the air gaps are equal.
- Whenever the iron bar at point A moves and alters the air gap, the bridge becomes unbalanced by an amount proportional to the change in inductance, which in turn is proportional to the displacement of the moving member.
- The increase and decrease of the inductance with varying air gap sizes is non-linear, and so is the output. Also, the flux density within the air gaps is easily affected by external fields.

Differential Output Transducers

- The Differential Output Transducer consists of a coil which is divided into two parts, as shown in below figure.



- Inductive transducers using self inductance as a variable use one coil, while those using mutual inductance as a variable use multiple coils.
- Normally the change in self inductance, ΔL, for inductive transducers, (working on the principle of change of self inductance) is not sufficient for detection of subsequent stages of the instrumentation system.
- However, if successive stages of the instrument respond to ΔL or ΔM, rather than $L + \Delta L$, or $M + \Delta M$, the sensitivity and accuracy will be much higher.
- The transducers can be designed to provide two outputs, one of which represents inductance (self or mutual) and the other the decrease in inductance (self or mutual).
- The succeeding stages of the instrumentation system measure the difference between these outputs. This is known as differential output.

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Advantages of Differential Output Transducer

- Sensitivity and accuracy are increased.
- Output is less affected by external magnetic fields.
- Effective variations due to temperature changes are reduced.
- Effects of change in supply voltages and frequency are reduced.
- In response to a physical signal (which is normally displacement), the inductance of one part increases from L to L + ΔL, while that of the other part decreases from L to L — ΔL.
- The change is measured as the difference of the two, resulting in an output of 2 ΔL instead of ΔL, when one winding is used.
- This increases the sensitivity and also eliminates error.

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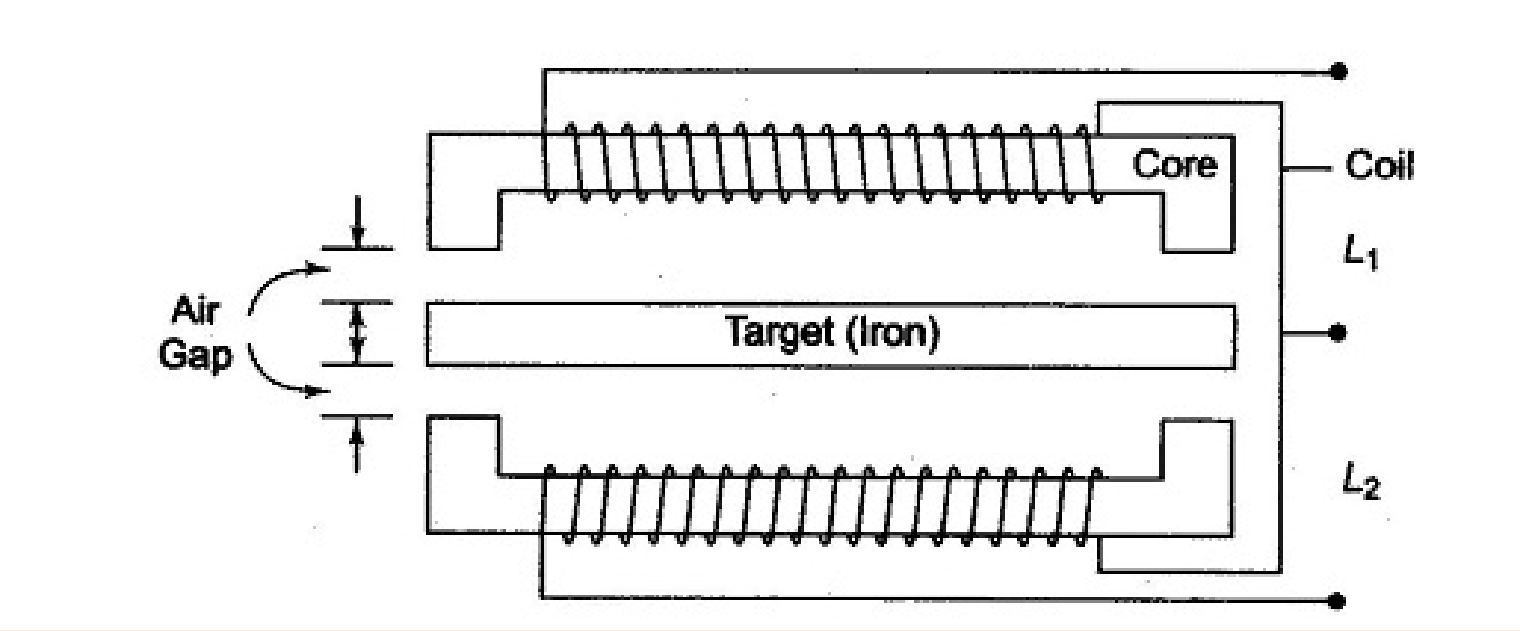
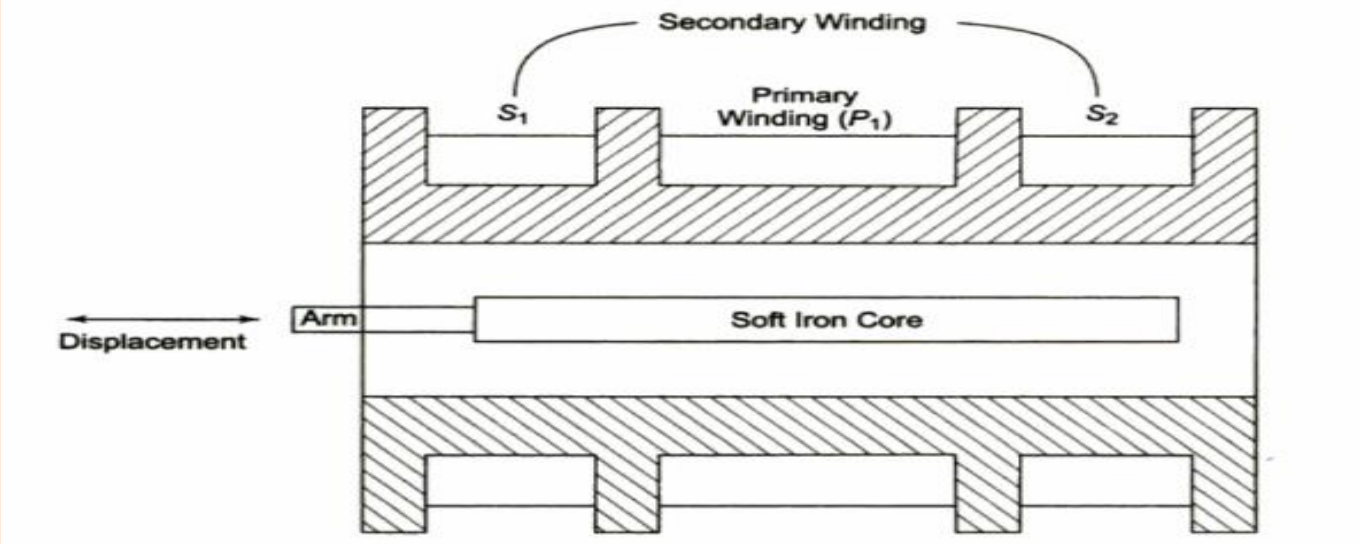
- Figure given below shows an inductive transducer giving a differential output. The output represents a change of self inductance due to change of reluctance. (This inductive transducer also works on the principle of change of self inductance of the two coils with change in reluctance of the path of the magnetic circuit. The target as well as cores on which the coil is wound are made up of iron.)



Linear Variable Differential Transformer (LVDT)



- The differential transformer is a passive transducer. It is also known as linear variable differential transformer (LVDT).
- The transformer consists of primary winding P1 and two secondary windings S1and S2 wound on a hollow cylindrical former.
- The primary winding is connected to an AC source. The secondary winding having equal number of turns and placed on the opposite side of primary winding.
- A movable soft iron core slides between the hollow core and effects the magnetic coupling between the primary and secondary winding.
- The displacement to be measured is applied to the arm attached on the soft iron core .

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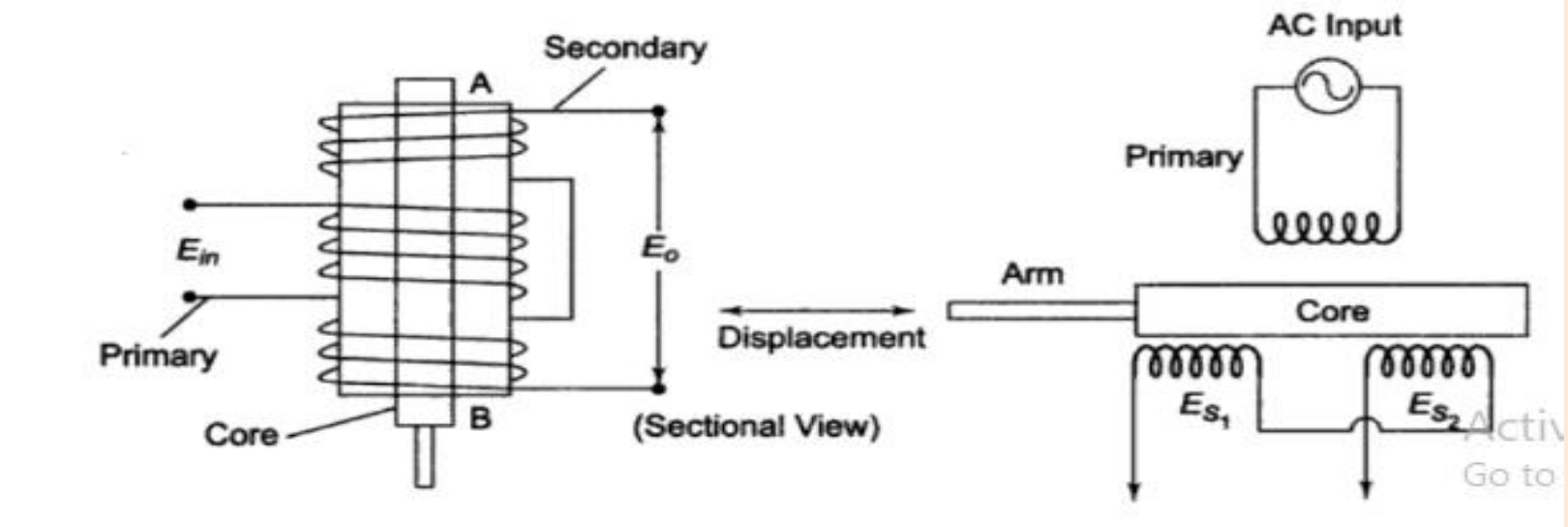

- When the core is in its normal position equal voltage is induced in both the secondary windings. The frequency of ac applied on primary winding is between 50Hz to 20KHz.
- The output voltage across the secondary S1 is Es1 and S2 is Es2. in order to convert S1 to S2 into a single voltage signal, the two secondary windings S1 and S2 are connected in series position.
- Hence the output voltage from the transducer is the difference of two voltages, Es1-Es2.
- When the core is at its normal position the flux linkage with the secondary windings is equal and hence equal emfs are induced in them. So at null position Es1=Es2.

Contd..

- When the core shifts to the left of null position, the flux linkage with the secondary winding S1 is more than S2, so the emf induced in the S1 is greater than S2.
- The magnitude of the output voltage across the secondary Es1-Es2, in phase with Es1.
- When the core shifts to the right of null position, the flux linkage with the secondary winding S2 is more than S1, so the emf induced in the S2 is greater than S1.
- The magnitude of the output voltage across the secondary Es2-Es1, in phase with Es2.
- The amount of the voltage induced is proportional to the amount of movement of the core.

Assignment Questions

- Describe the operation of differential output.
- State the advantages of differential output.
- Describe with the help of diagram the construction of an LVDT.
- List the characteristics of LVDT.
- Explain the method of measuring displacement using LVDT.
- State the advantages and disadvantages of LVDT.

Conceptual Questions

- An inductive transducer measures the variation in _____
  a) reluctance
  b) resistance
  c) capacitance
  d) self-inductance
- Inductive transducer is used for the measurement of physical quantities.
  a) True
  b) False
- Self-inductance depends on _____
  a) permeability
  b) permittivity
  c) plank’s constant
  d) rydberg constant

Contd..

- What is the principle of operation of LVDT?
  a) Mutual inductance
  b) Self-inductance
  c) Permanence
  d) Reluctance
- LVDT is a
  a) pressure transducer
  b) B. displacement transducer
  c) velocity transducer
  d) acceleration transducer
- LVDT windings are wound on
  a) Steel sheets
  b) Aluminium
  c) Ferrite
  d) Copper

Contd..

Advantage of LVDT

a) 0.05% linearity and finite resolution
b) High output and high sensitivity
c) Rugged and less friction
d) Low hysteresis and low power consumption

LVDT is an/a _____ transducer

a) Magneto-strict ion
b) Inductive
c) Resistive
d) Eddy current

In a LVDT, the two secondary voltages

a) Are independent of the core position
b) Vary unequally depending on the core position
c) Vary equally depending on the core position
d) Are always in phase quadrature

Contd..

. The application of LVDT is

a) Joint motion
b) Finger movement
c) Limb movement
d) Heart wall motion

Strain gauge, LVDT and thermocouple are examples of

a) Active transducers
b) Passive transducers
c) Analog transducers
d) Primary transducers

THANK YOU