MODULE V

Digital Multimeter :

Digital Multimeter is an instrument which measures AC. and DC. voltages, currents and resistances over a wide range .

- **Digital** : indicates that the device has a digital or LCD output .
- **Multimeter** : indicates that a single device can be used for multipurpose measurement.

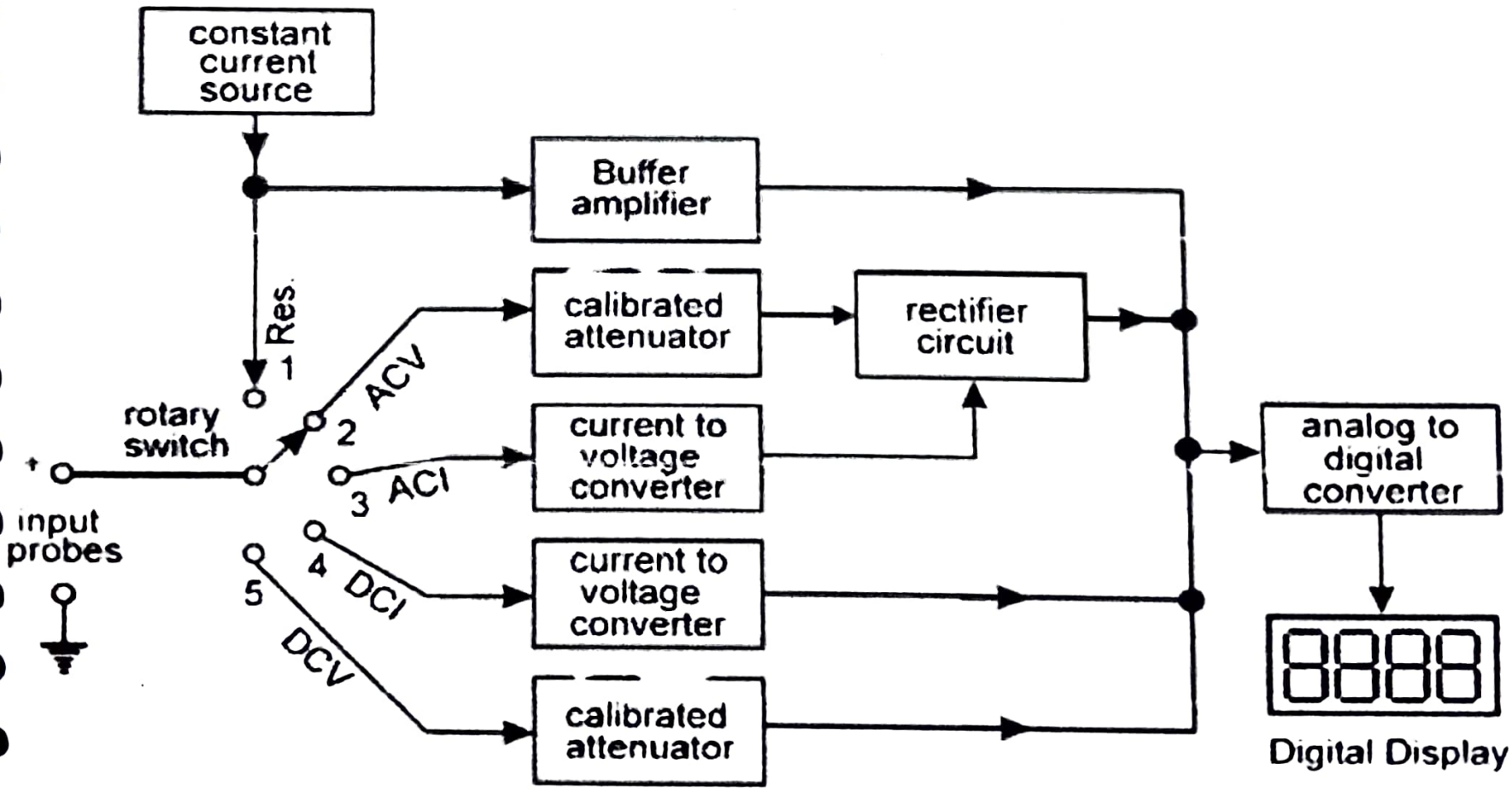
Parts Of Digital Multimeter :

1. Display Screen : It has illuminated display screen for better visualization .It is having five digits display over the screen.

   one for sign value
   four for number representation

2. Selection knob : Multimeter is used fore several measurements like voltage, current & resistance. The selection knob allows the user to select different measurements.
3. Port :
   - Two port :
     1. MAVΩ port(Red probe '+')
     2. COM port(Black probe '_')
   - 10A Port : Current port which can measure large current .

Block diagram :



1. Resistance
2. ACV (Alternating Voltage)
3. ACI (Alternating current)
4. DCI (Direct current)
5. DCV (Direct voltage)

- The current is converted into voltage by parsing it through low shunt resistance.
- The ac. quantities are converted to dc. quantities by employing various rectifier and filtering circuits .
- The resistance measurement consists of a low current source that is applied across an unknown resistance .

Voltage Measurement :

fore measurement of A-c voltage, the i/p voltage is fed through a calibrated compensated attenuator to a precision full wave rectifier followed by a ripple reduction filter .

Current Measurement :

for current measurement, the drop across an internal calibrated shunt is measured directly by the Analog to digital converter in the "d-c. current mode" after ac to dc conversion in the "ac current mode" resistance Voltage drop . $V = IR$ so $I = V/R$.

Resistance Measurement :

Digital multimeter measures the voltage across the externally connected resistance, resulting from a current a current forced through it from Calibrated current source. $V = IR$ so $R = V/I$.

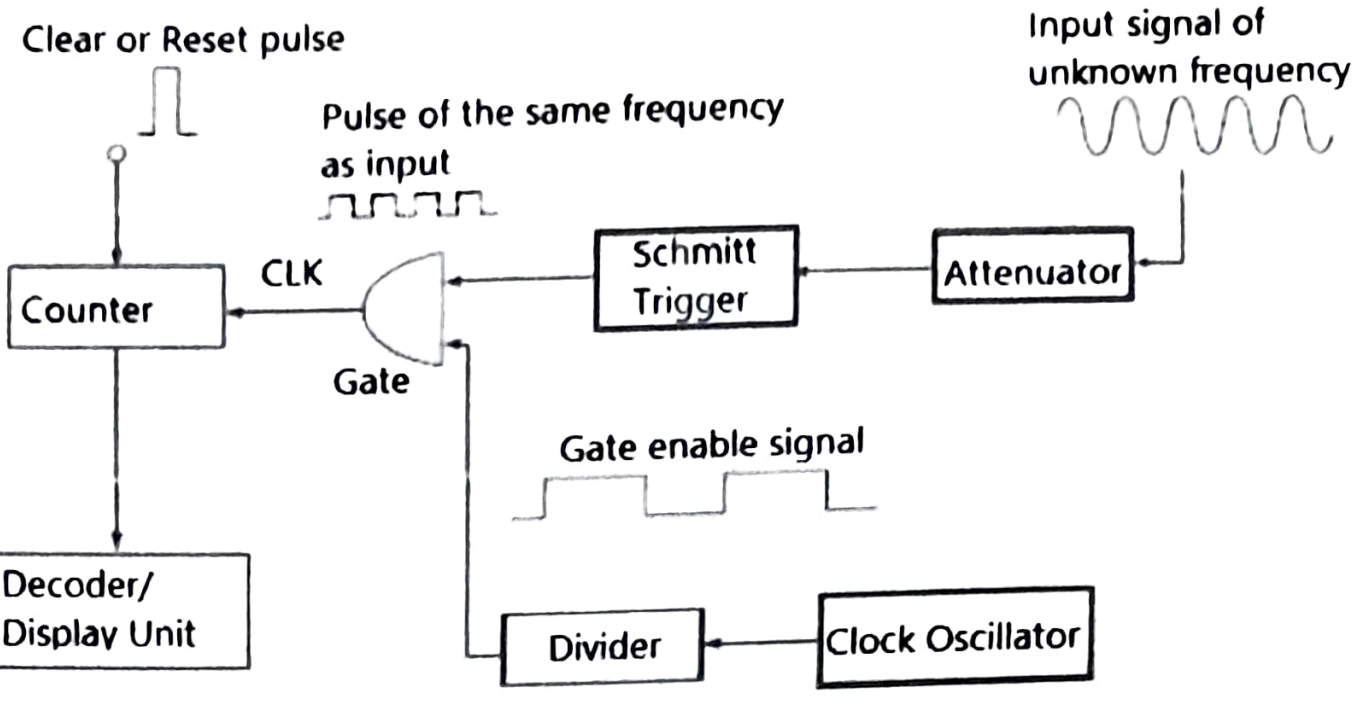
Digital Frequency meter :

- This device measures and display the frequency of any periodic waveform.
- Operates on the principle of getting the unknown input signal into the counter for predetermined time.
- The term "gated" comes from the fact that an "AND" or an "OR" gate is employed for allowing the unknown input signal into the counter to be accumulated.
- It consist of a counter with its associated display/decoded circuitry, clock oscillator ,a divider & an AND gate.

Counter :

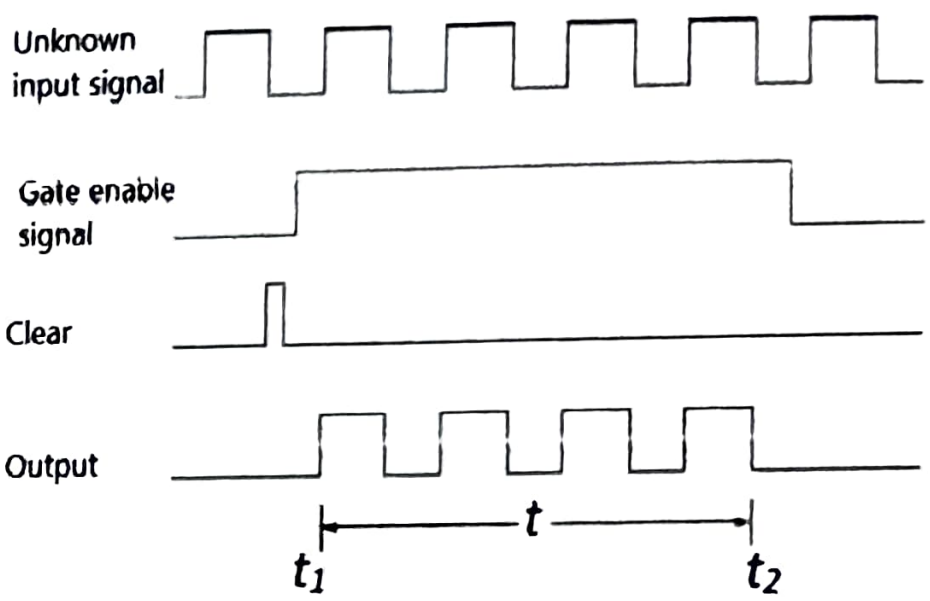
- Binary coded Decimal counter (BCD) output into a decimal output.
- gate enable signal of known time period is generated with a clock oscillator and a divider circuit is applied to one leg of and gate.
- The counter advances one count for each transition of the unknown signal and at the end of the known time interval, the content of the counters will be equal to the number of periods of unknown input Signal that have occurred during time interval t.
- counter content will be proportional to the frequency of the unknown input signal

Block Diagram :



Working:

- A clear pulse is applied to the counter at t_0 to set the counter at zero.
- **Prior to t_1 : gate enables is & low, so o/p of the AND Gate will be low & the counter will not be counting.**
- **from t_1 to t_2 : Gate enable signal is high, the unknown input signal passes through the AND gate & counter starts counting.**
- **After t_2 : Gate enable signal is goes low so the counter will stop counting.**
- the counter will have counted the number of pulses that occurred during the time interval t.
- The resulting content of the counter are a direct measure of the frequency of the input signal.



Transducer :

- Transducer convert one form of energy to electrical energy for measurement purposes.
- Transducer contains two parts :
  1. **Sensing element :** It is called sensor . It is device producing measurable response to change in physical condition.
  2. **Transduction element :** It convert sensor output to suitable electrical form.

- Parameter e.g. temp, force etc . → Sensing Element → Transducer Element → Electrical energy

Basic requirements of transducer :

1. **Linearity :** Input vs Output characteristics must be linear.

2. **Ruggedness :** transducer should be capable of withstanding overload.
3. **Repeatability :** The device showed reproduce the same output signal when the same input signal is applied again and again under the unchanged environment.
4. **High reliability stability :** The transducer should give minimum error for temp. variation , other change in environment.
5. **High output signal :** S/N should be high . Where S = signal and N = noise .
6. **NO Hysteresis**
7. **Residual Reformation :** there should not be any deformation on of input signal of after long period of use .

Advantage of transducer :

a. Power requirement is very low for controlling the electrical system.
b. Friction effect is minimized.
c. Mass-inertia effect are also minimized.
d. An amplifier may be used for amplifying the electrical signal according to the requirement.

Classification of transducer :

- Active and passive transducer.
- Analog and Digital transducer.
- Primary and secondary transducer.
- Transducer and inverse transducer.
- On basis of principle of working .

Active transducer :

1. Don't need any external source of power for their operation.
2. They are self generating device .
3. Output we get is equivalent to the electrical output signal.
4. Example: photovoltaics and piezo electric sensor .

Passive transducer :

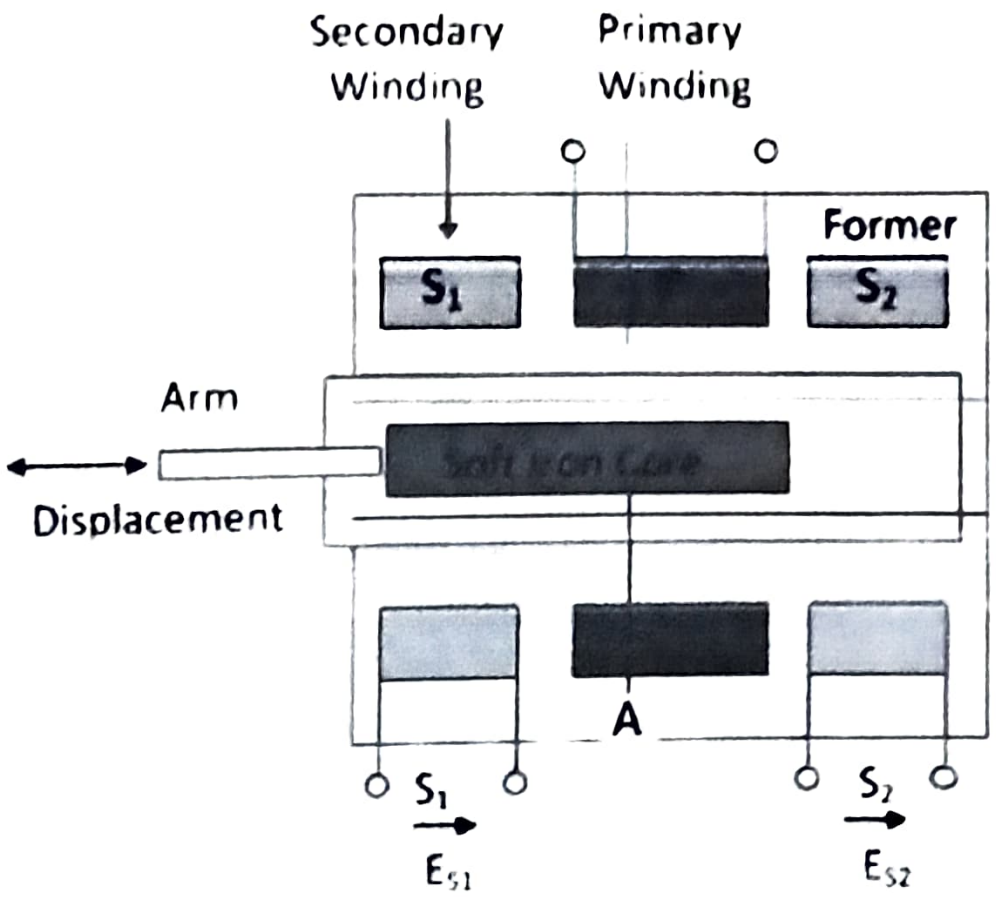
1. It requires an external source of power for operation .
2. DC power supply or audio frequency is used as external source .
3. Output signal is in form of variation in resistance, capacitance, inductance or other electrical parameter.
4. Example: LVDT, thermistor, strain gauge

LVDT :

- LVDT stands for linear variable differential transducer .
- LVDTS are sensor used to monitor linear displacement that converts linear motion into electrical signal .

Construction :

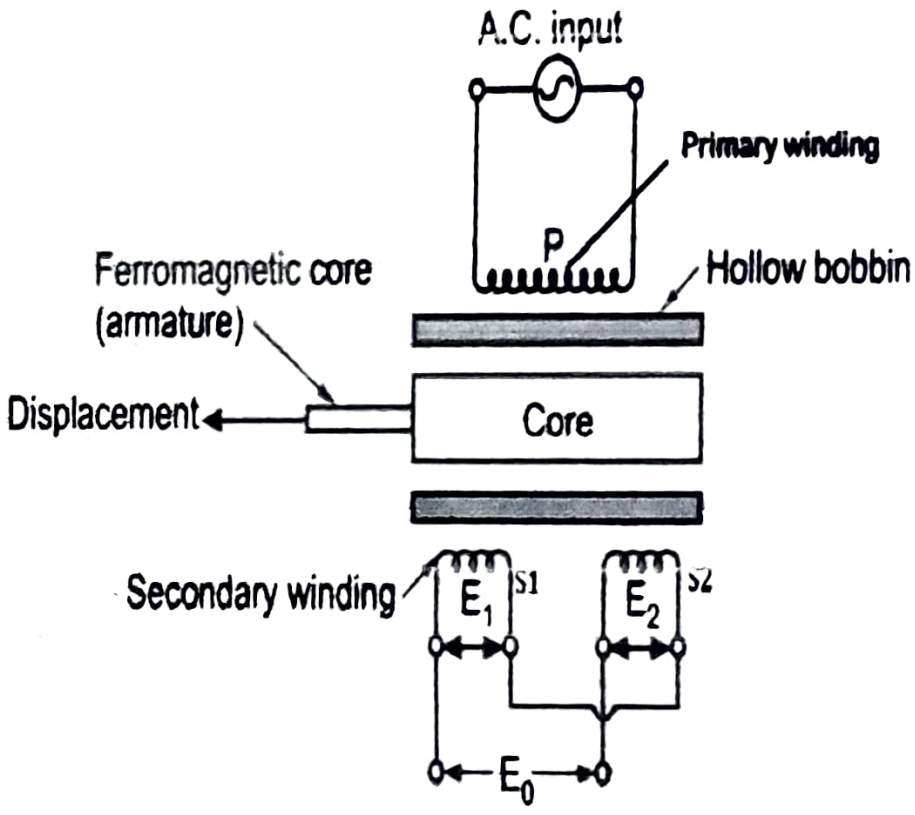
- A typical LVDT consists of a cylindrical transformer that carries 3 coils that is one primary coil at center of the transformer and two secondary coil on either side of the primary coil .
- Two secondary coils have unequal number of tones but are opposite to each other .
- A movable soft iron core slides within the hollow space of the cylindrical transformer and therefore at fact the magnetic coupling between primary and secondary coil .
- A moveable soft iron core slides with in the hollow space of the cylindrical transformer and the therefore affect the magnetic coupling between the primary and secondary coil .



Working principle :

- When the primary coil is given to AC supply , current flow through the primary coil and it further induced the current in the secondary coil according to Faraday's law of electromagnetic induction.
- Thus if the emf generated in one secondary coil be E_1 and emf generated in other secondary coil be E_2
- Thus net emf

  $E_0 = E_1 - E_2$



Working :

Based on the position of the soft iron core there are three cases →

- **Case -1**: When the core is at the center position the amount of flux induced in primary and secondary are equal as well as the voltage induced in the primary and secondary is also equal ($E_1 = E_2$).

  $E_0 = E_1 - E_2 = 0$
- **Case -2:** When the core is at left at that position more flux is induced in the left side that is in the S1 side hence the emf in S1 side is greater than S2 side ($E_1 > E_2$).

  $E_0 = E_1 - E_2 > 0$ (+VE)
- **Case -3:** When the core is at right hand side then the flux induced in the right hand side is more as a result of which the EMF induced in the right hand side that is in the S2 side is more than S1 ($E_1 < E_2$).

$$E_0 = E_1 - E_2 < 0 \text{ (-VE)}$$

Advantages :

I. Sensitivity is high.
II. It consumes low power and hence produces low stresses loss.
III. Linearity is good.
IV. Output is rather high.

Disadvantage :

I. Sensitive to stray magnetic field.
II. Affected by temperature and vibration.
III. Lvdt has large threshold.

Strain Gauge

- The strain gauge is an electrical transducer, it is used to measure mechanical surface tension.

Strain gauge can detect and convert force or small mechanical displacement into electrical signals. On the application of force a metal conductor is stretched or compressed, its resistance changes owing to the fact both length and diameter of conductor change.

- The strain gauges are used for measurement of strain and associated stress in experimental stress analysis. Secondly, many other detectors and transducers, for example the load cell, torque meter, flow meter, accelerometer employ strain gauge as a secondary transducer.
- Also, there is a change on the value of resistivity of the conductor when it is strained and this property of the metal is called piezo resistive effect. Therefore, resistance strain gauges are also known as piezo resistive gauges.

Theory of Resistance Strain Gauges

- The change in the value of resistance by the application of force can be explained by the normal dimensional changes of elastic material.
- If a positive strain occurs, its longitudinal dimension (x-direction) will increase while there will be a reduction in the lateral dimension (y-direction).
- The reverse happens for a negative strain. Since the resistance of a conductor is directly proportional to its length and inversely proportional to its cross-sectional area, the resistance changes.
- The resistivity of a conductor is also changed when strained. This property is known as piezoresistive effect.

Gauge factor

Gauge factor is defined as the ratio of fractional change in electrical resistance to the fractional change in length (strain): The Gauge Factor for metallic strain gauges is typically around 2. Ideally, we would like the resistance of the strain gauge to change only in response to applied strain.

PYQ'S ASKED IN MID & END SEMESTER EXAMINATIONS

MODULE V

2MARKERS

1) Explain the working of multimeter.
2) What is gauge factor?

4MARKERS

1) Write a short note on digital frequency meter.
2) What is electronic voltmeter ? AND its benefits.
3) Explain principle operation of LVDT?
4) Draw and explain block diagram of multimeter.

*For hints & solutions refer to the notes or for detail solution contact your mentor. (your mentor will be assigned you soon)