EEE1024: Fundamentals of Electrical and Electronics Engineering

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Module -6 Syllabus

- **Measuring Instruments:**

  Classification of instruments, Working principle of PMMC, MI, Digital & Smart Meters, Ammeter, Voltmeter & wattmeter.

- **Sensors:**

  Transducers classification& selections, Resistive, Inductive and capacitive sensors, Optical and Digital sensors.

Smart Meters

***SMART METERS* – EDF Energy**

Feb 11, 2020 Artificial Intelligence and the Future for Smart ...
www.ifc.org

Artificial intelligence will play a pivotal role in this effort **by using** data—including **grid** data, **smart meter** data, weather data, **and** energy **use** information—to study **and** improve building performance, optimize resource consumption, **and** increase comfort **and** cost efficiency for residents.

MEASURING INSTRUMENTS

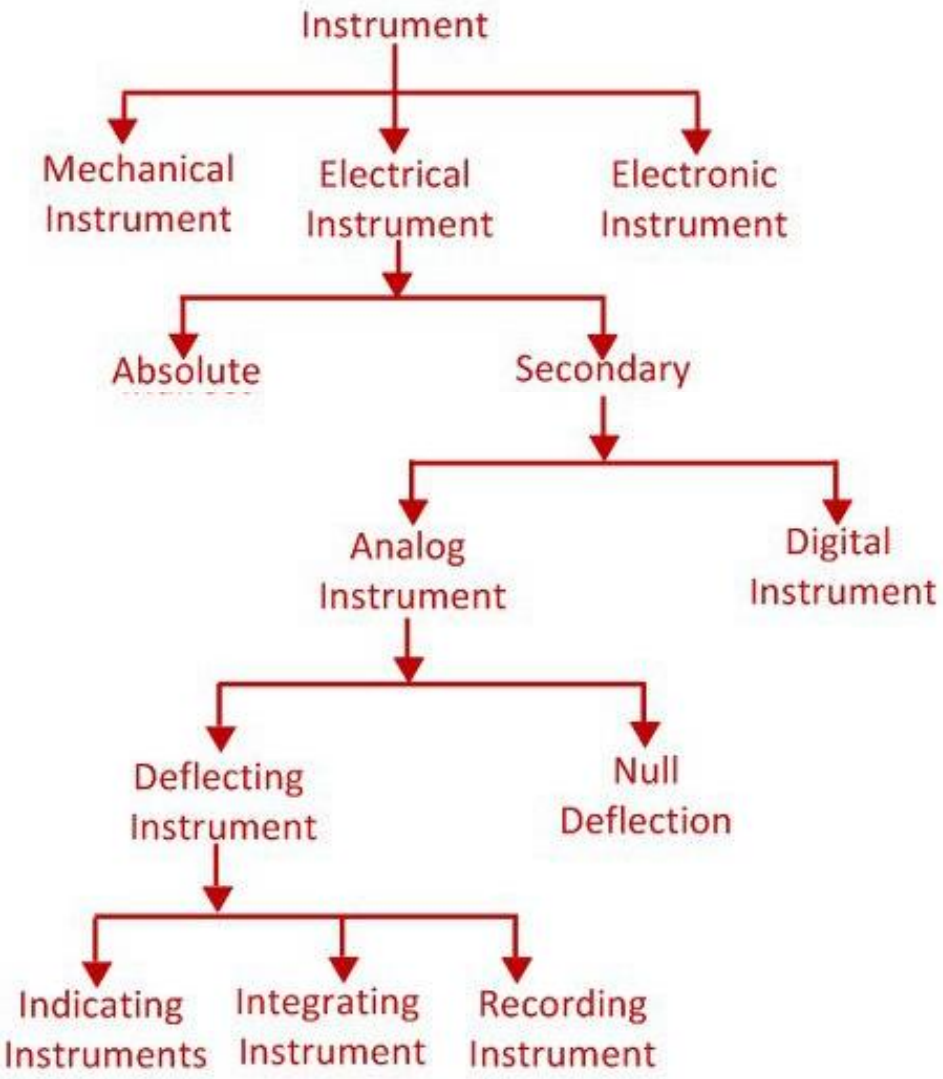
Classification of Instruments - I

- The instrument used for measuring the physical and electrical quantities is known as **measuring instrument.**

- "Measurement" - the comparison between the two quantities of the same unit.

- The magnitude of one of the quantity is unknown, and it is compared with the predefined value.

Classification of Instruments - II



Classification of Instruments - III

Mechanical instrument:

Mechanical instruments are very reliable for static and stable conditions. As they use mechanical parts these instruments cannot faithfully follow the rapid changes which are involved in dynamic instruments. But they are cheaper in cost and durable.

Electrical Instruments:

When the instrument pointer deflection is caused by the action of some electrical methods then it is called an electrical instrument. The time of operation of an electrical instrument is more rapid than that of a mechanical instrument.

Electronic Instruments:

Electronic instruments use semiconductor devices. They are very fast in response. With the use of electronic devices, a very weak signal can be detected by using pre-amplifiers and amplifiers.

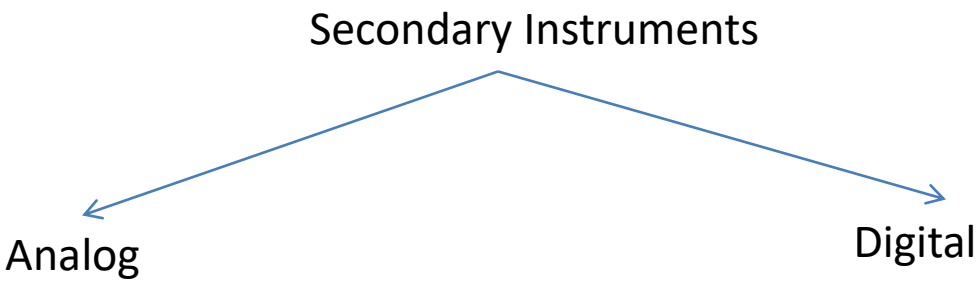
Absolute Vs Secondary

Absolute Instruments

Absolute instrument measures the process variable directly from the process without the use of conversion. Such instruments do not require comparison with any other standard. Eg. – tangent galvanometer

Secondary Instruments

These instruments are so constructed that the deflection of such instruments gives the magnitude of the electrical quantity to be measured directly. These instruments are required to be calibrated with respect to the standard instrument.



Analog Vs Digital

ANALOG Instruments

Signals of an analog instrument vary in a continuous fashion and can take on an infinite number of values in a given range.
Eg: **Ammeter and voltmeters**, wristwatch, speedometer

DIGITAL Instruments

Signals of digital instruments vary in discrete steps and take a finite number of different values in a given range. They have high accuracy and high speed of operation.
Eg: Digital Multimeter

Analog Instruments – Deflecting Vs Null Deflection

Deflection-type Instruments

- Deflection of the instrument indicates the measurement of the unknown quantity.
- Some physical effect which deflects or produces a mechanical displacement
- Deflection or the mechanical displacement of the moving system is balanced by an opposing actuating cause producing the deflection or the mechanical displacement.

Eg: Permanent Magnet Moving Coil (PMMC), Moving Iron (MI)

Null-type Instruments

- In these instruments, a zero or null indication leads to the determination of the magnitude of the measurand quantity.
- The null condition depends upon some other known conditions.
- These are more accurate and highly sensitive as compared to deflection-type instruments.

Eg: DC Potentiometer

Deflecting Instruments - I

Indicating Instruments

These instruments measure and indicate the magnitude of the electricity. The indications are given by a pointer moving over a calibrated scale.
Eg: Ammeters, Voltmeters, Wattmeters, Frequency meters, Power factor meters

Integrating Instruments

These instruments measure the total amount of either quantity of electricity (ampere-hours) or electrical energy supplied over a period of time.
Eg: Energy meters and Ampere-hour meters

Recording Instruments

These instruments continuously record the variation of the magnitude of the electric quantity for a definite period of time.
Eg: Meters used in powerhouses where the current, voltage, power, etc., are to be maintained within a certain acceptable limit.

Deflecting Instruments - II

PMMC – Working Principle

PMMC – *Permanent Magnet Moving Coil*

- Instrument that allows you to measure the current through a coil by observing the coil's angular deflection in a uniform magnetic field.

- A PMMC meter places a coil of wire (i.e. a conductor) in between two permanent magnets in order to create stationary magnetic field.

- According to Faraday's Laws of electromagnetic induction, a current carrying conductor placed in a magnetic field will experience a force

- The magnitude (strength) of this force will be proportional to the amount of current through the wire. A pointer is attached to the end of the wire and it is put along a scale.

PMMC – *Working Principle*

- D' Arsonval – French physician, physicist, and inventor

- Current in coil - produces force or torque (rotational force), called as ***deflecting torque***
  ….Faraday's law of electromagnetic induction

- Controlling torque - produced by springs attached to the moving coil – balances the deflecting torque

- Deflection of the pointer is calibrated against a scale and it is proportional to the current flowing through the coil.

PMMC

MI –
WORKING PRINCIPLE

MI – *Moving Iron Instruments*

- Most primitive measuring instruments

- These instruments use the effect of attraction or repulsion of a piece of iron towards a magnet (or an electromagnet)

CONSTRUCTION:

✓The plate or vane of soft iron is used as the moving element of the instrument. The vane is so placed that it can freely move in the magnetic field of the stationary coil.

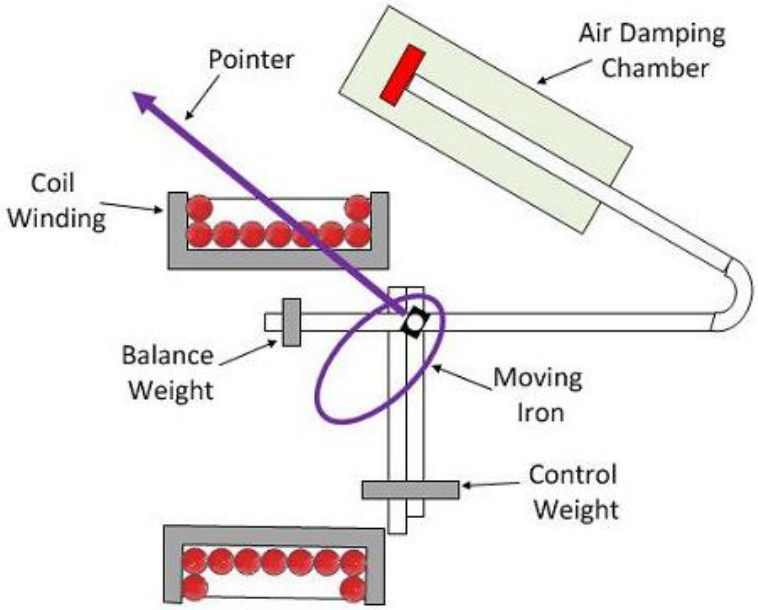
✓The conductor makes the stationary coil, and it is excited by the voltage or current whose magnitude is used to be measured.

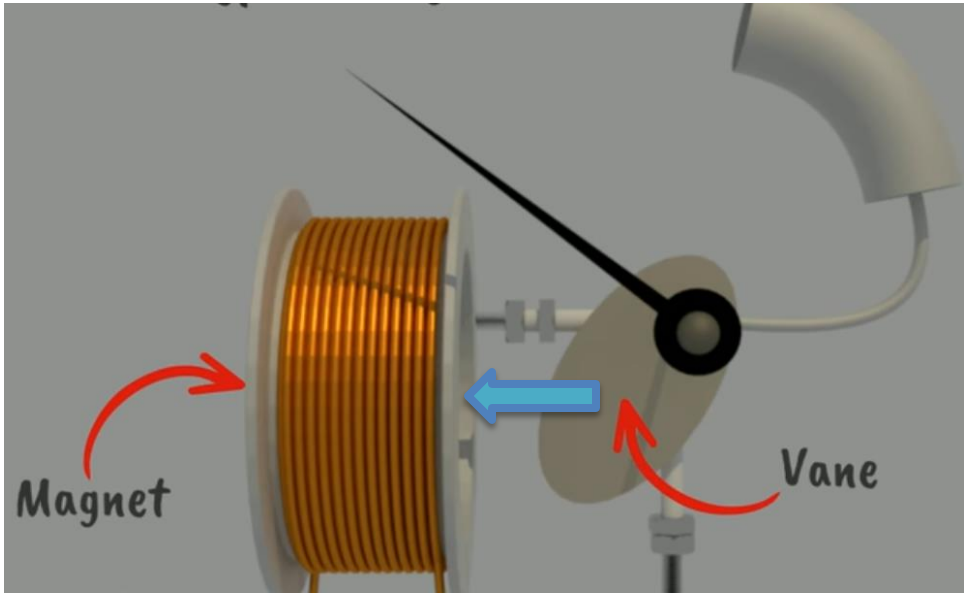
✓The moving iron instrument uses the stationary coil as an electromagnet.

✓The electromagnet is the temporary magnet whose magnetic field strength increases or decreases with the magnitude of the current passes through it.

Types of *MI* Instruments - I

Attraction type MI Instrument



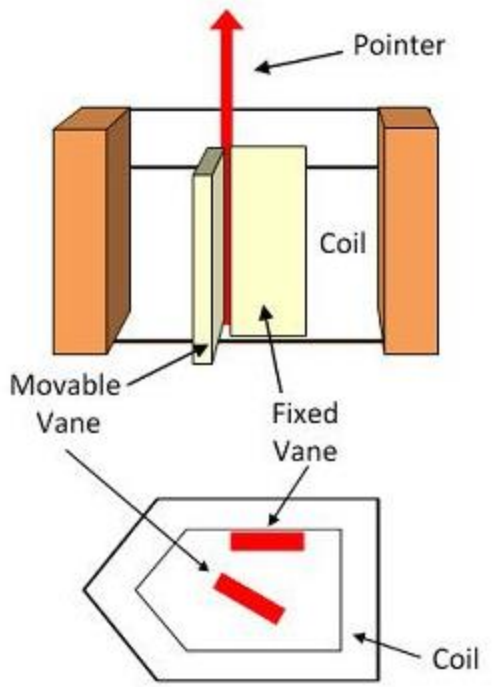


1. Magnetic field of the electromagnet can be easily increased or decreased by controlling the amount of current through the coil.

2. The Vane or moving coil is attracted in proportion to the magnetic field and the calibrated pointer moves accordingly.

Types of *MI* Instruments - II

Repulsion type MI Instrument



❑ Repulsion type instrument has two vanes or iron plates. One is fixed, and the other one is movable.

❑ When current flows through the coil, it magnetizes both the vanes and produce similar polarity at the same end!

❑ Thus, a repulsive force is produced

❑ Because of a repulsive force, the moving coil starts moving away from the fixed vane.

❑ The calibrated pointer, moves in proportion to this repulsive force.

Differences between PMMC and MI instruments

Properties	Moving Iron	Moving Coil
Construction	Iron is used as moving mechanism	Conductor Coil is used as Moving mechanism
Working Principle	Magnetism	same as Dc motor
Damping torque	Air friction	Eddy current damping
Power consumption	More	Less
Scale	Non-Uniform	Uniform
Sensitivity	Less	More
Accuracy	Less	More
Application	DC and AC	DC only

Acknowledgements

1. https://circuitglobe.com/classification-of-measuring-instruments.html
2. https://automationforum.co/classification-of-measuring-instruments/
3. https://www.electrical4u.com/permanent-magnet-moving-coil-instrument/
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5. https://www.youtube.com/watch?v=8MPwPNGjuj4
6. https://www.youtube.com/watch?v=ZtBKC6WSjD0
7. https://electronicslesson.com/measuring-instruments/difference-moving-iron-moving-coil-instrument/