Assignment-6 (Electrical)

(Measuring Instruments).

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DTU/2K17/B9/1178.

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1. Permanent moving magnet coil type.

The basic principle of operation is that when a current carrying conductor is brought in a magnetic field, a torque on the conductor is produced. The instrument consists of a rectangular coil piuated so that its sides lie in the air gap between the two poles of a permanent magnet and a soft-iron cylinder. The air gap between the magnet poles and iron core is small and the flux density is uniform and is in a radial direction, so that the flux lines are always at right angles to the current carrying conductor and hence when current passes through the coil, a deflecting torque is produced owing to the interaction between the two fluxes, one due to permanent magnet and the other due to magnetic field of the coil.

Now, if N is the no. of turns in the coil, B is the magnetic flux density due to permanent magnet, I is the current in the coil, l is the effective length, the force acting on the coil is given by

$F = NBIl$ Newton — (I)

Hence, the torque in the coil, l the effective length,

$T = NBIl \cdot 2r$ N-m — (II)

In any measuring instruments there are three torques acting on the moving mechanism to which a pointer is connected which moves on the dial of the instrument and indicates the reading of the quantity being measured. One of the three torques is the deflecting torque which have just studied. The other torques are (I) control. torque (II) Damping torque.

In case of PMMC instruments spring made of phosphor bronze provides control torque. The spring also serves as leads to the moving coil. When deflecting torque acts as on the coil, both the control torque and damping torques come in action. The control torque restrains the rotation of the coil whereas the deflecting torque tries to rotate the coil. At balance, if the coil has moved through

an angle θ and if K is the spring constant we have

$$NBIl \cdot 2r = K\theta$$

or
$$I = \frac{K\theta}{NBl \cdot 2r}$$

$$= K'\theta$$

Following are the advantages of PMMC instruments :-

(a) Low Power Consumption

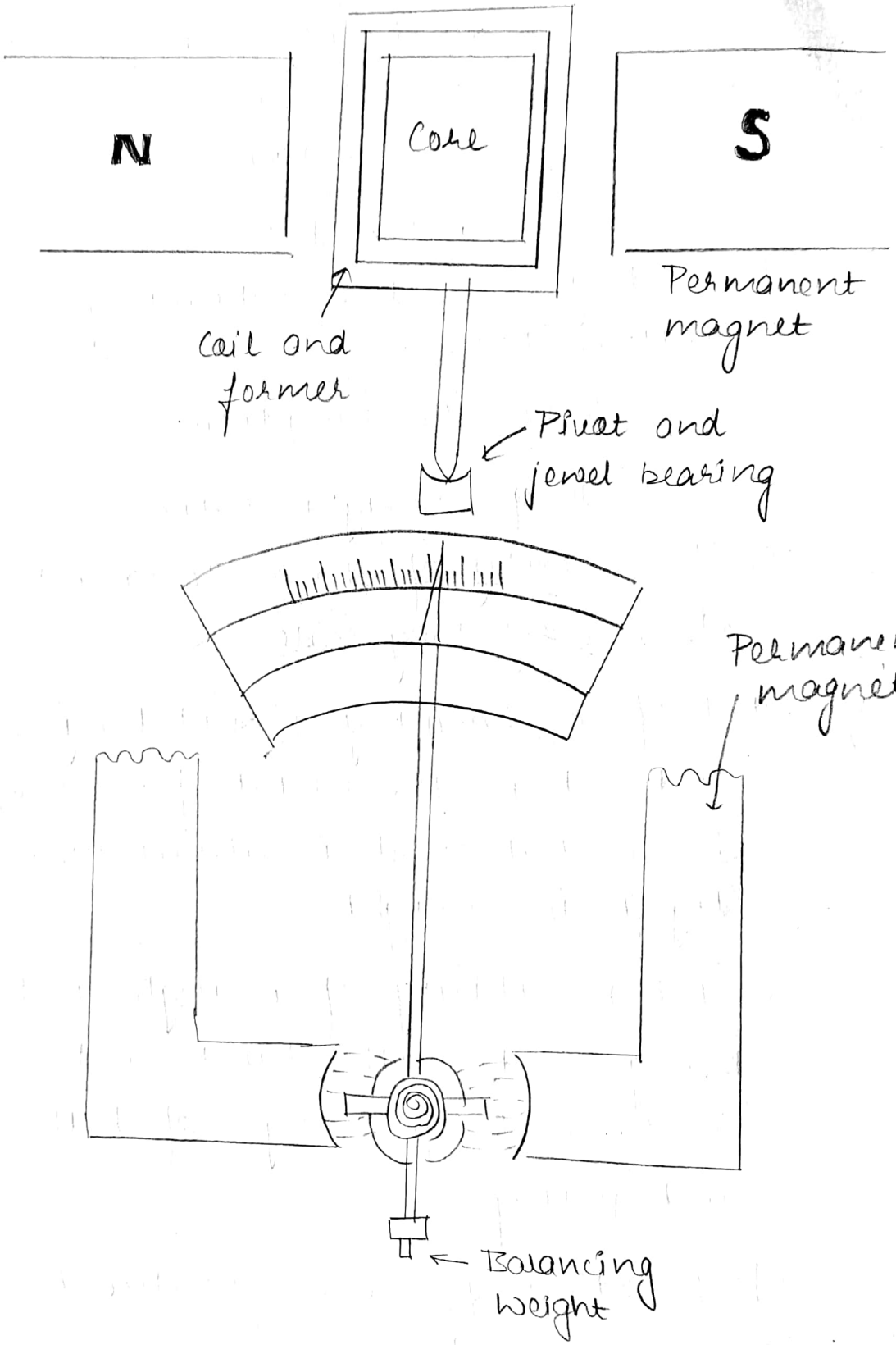
(b) High Torque/weight - ratio

(c) Uniformity of the scale and the possibility of a very long scale.

(d) Perfect damping provided by eddy currents induced in the metal former of the coil. The metal used is aluminium as it is light in weight.

(e) The possibility of a single instrument being used with shunt and resistance to cover a large range of both currents and voltages.

(f) Freedom from errors due to stray magnetic fields.



Permanent magnet moving instrument

2. Moving Iron Type (Ammeter/Voltmeter).

Moving-iron instruments are generally used to measure alternating voltages and currents. In moving iron instruments the movable system consists of one or more pieces of specially-shaped soft iron, which are so pivoted as to be acted upon by the magnetic field produced by the current in coil.

There are two general types of moving-iron instruments namely:

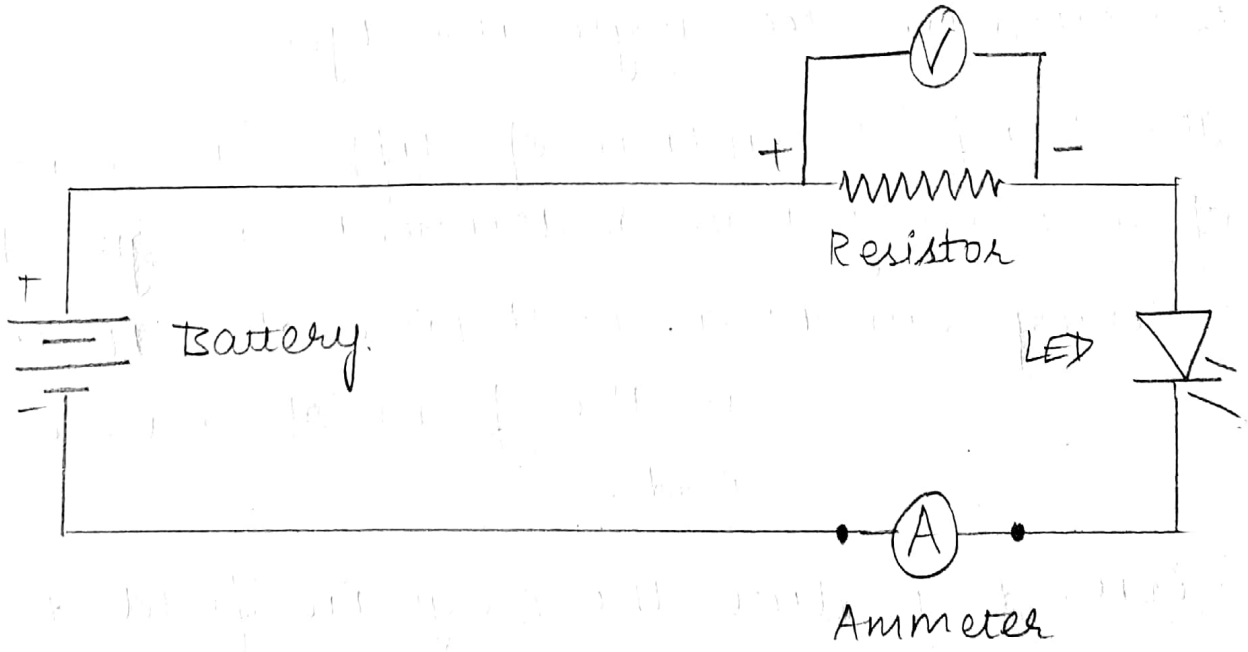
(1.) Repulsion (or double iron) type

(2.) Attraction (or single iron) type

The brief description of different components of a moving-iron instruments is given below:

- Moving element: a small piece of soft iron in the form of a vane or rod.
- Coil: to produce the magnetic field due to current flowing through it and also to magnetize the iron pieces.

- On repulsion type, a fixed vane or rod is also used and magnetized with the same polarity.
- Control torque is provided by spring or weight (gravity).
- Damping torque is normally pneumatic, the damping device consisting of an air chamber and a moving vane attached to the instrument spindle.
- Deflecting torque produces a movement on an aluminium pointer over a graduated scale.



Typical scheme of measuring el. current and voltage.

Measurement of Electric Voltage and Current

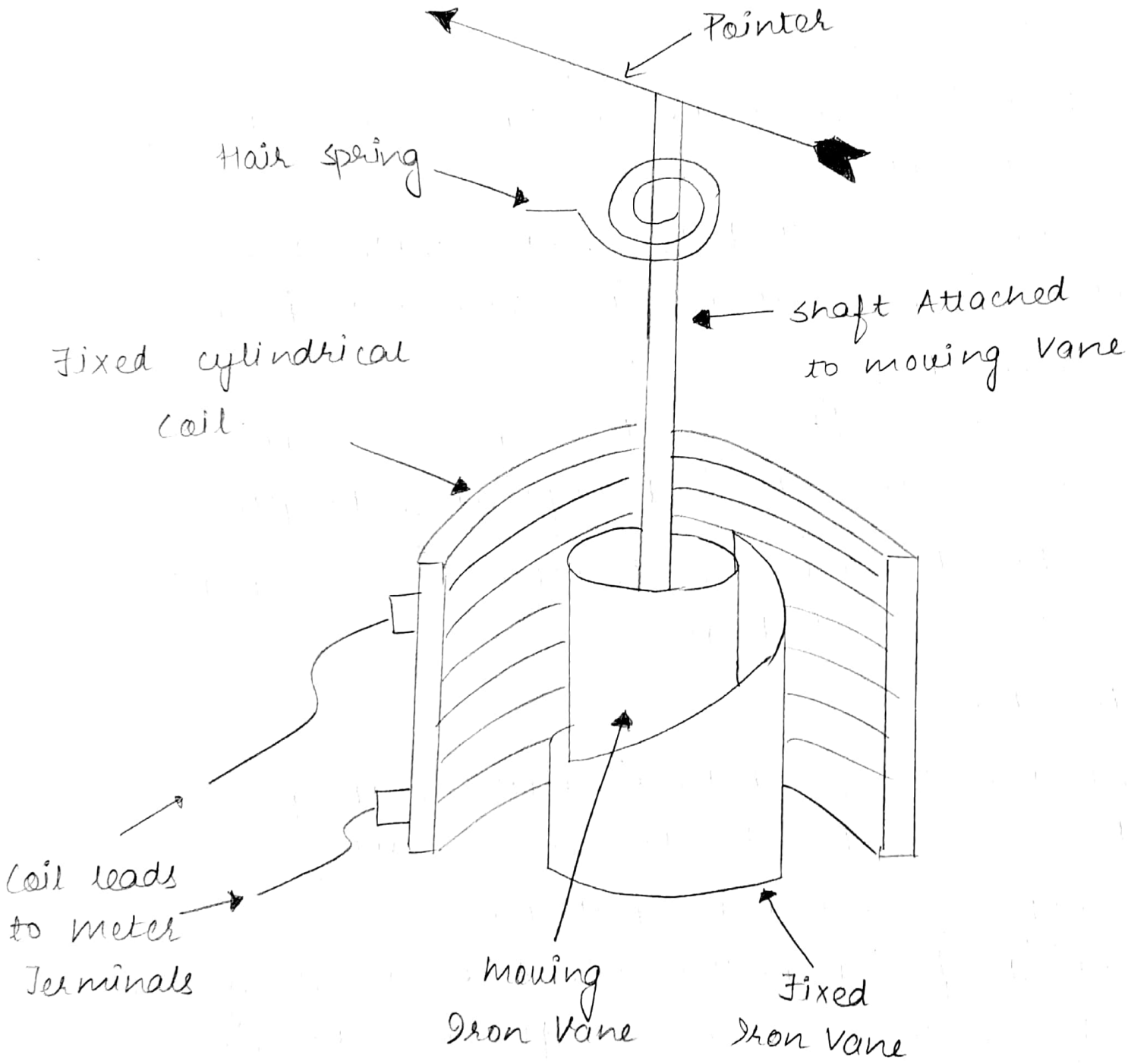
- Moving iron instruments are used as Voltmeter and Ammeter only.
- Both can work on AC as well as on DC.

Ammeter

- Instrument used to measure current in the circuit.
- Always connected in series with the circuit and carries the current to be measured.
- This current flowing through the coil produces the desired deflecting torque.
- It should have low resistance as it is to be connected in series.

Voltmeter

- Instruments used to measure voltage between two points in a circuit
- Always connected in parallel.
- Current flowing through the operating coil of the meter produces deflecting torque
- It should have a high resistance. Thus a high resistance of order of kilo ohms is connected in series with the coil of the instrument.



Repulsion moving Iron - Instrument

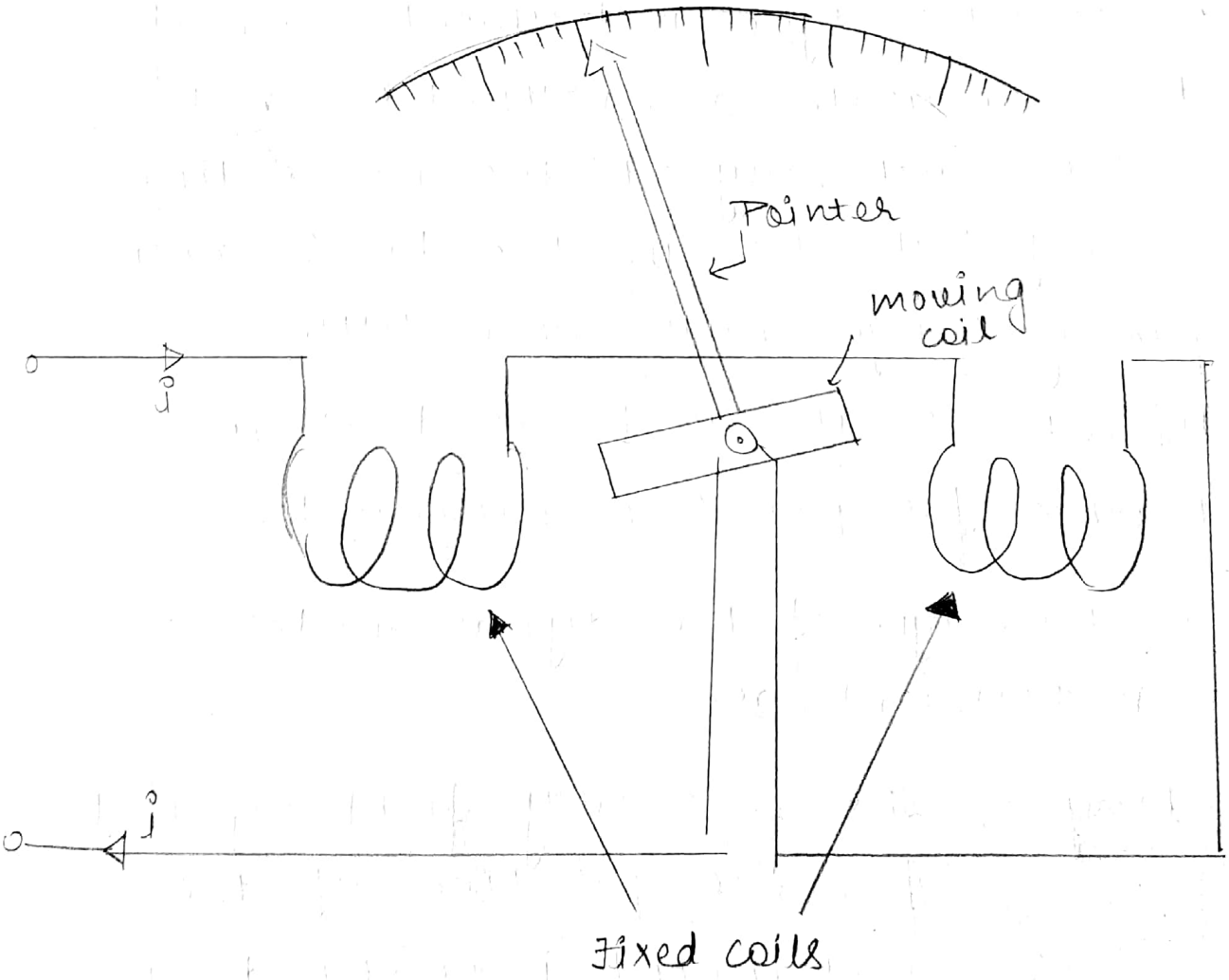
5. Dynamometer type instruments.

The electrodynamometer type instrument is a transfer instrument. A transfer instrument is one which is calibrated with a d.c. source and used without any modification for a.c. measurements. Such a transfer instruments has same accuracy for a.c. and d.c. measurements. The electro-dynamometer type instruments are often used in accurate a.c. voltmeters and ammeters, not only at the power line frequency but also in the lower audio frequency range. With some little modifications, it can be used as a wattmeter for power measurements.

The various type of the dynamometer type instrument are:

Working :- The necessary field required for the operation of the instrument is produced by the fixed coils. A uniform field is obtained near the

center of coil due to division of coil in two sections. These coils are air cored. Fixed coils are wound with fine wire for using as voltmeter, while for ammeters and wattmeters it is wound with heavy wires. The coils are usually varnished. They are clamped in space against the coil supports. This makes the construction rigid.



Electrodynamometer type Instrument

6. Multimeters

A multimeter or a multitester, also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instruments that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Analog multimeters use a microammeter with a moving pointer to display readings. Digital multimeters are now far more common due to their cost and precision, but analog multimeters are still preferable in some case, for example when monitoring a rapidly varying value.

A multimeter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high value of accuracy. They can be used to troubleshoot electrical problems in a

wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

A multimeter is a combination of a multirange DC voltmeter, multirange AC voltmeter, multirange ammeter, and multi range ohmmeter. An unamplified analog multimeter combines a meter movement, range resistors and switches; VTVM's are amplified analog meters and contain active circuitry.

For an analog meter movement, DC voltage is treated with a series resistor connected between the meter movement and the circuit under test.

7. A-C watt hour meter

Energy meter or watt hour meter is an electrical instrument that measures the amount of electrical energy used by the consumers. Utilities is one of the electrical departments, which install these instruments at every place like homes, industries, organizations, commercial buildings to charge for the electricity consumption by loads such as light, fans, refrigerator and other home appliances.

Basic unit of power is watts and it is measured by using a watt meter. One thousand watt makes one kilowatt. If one uses one kilowatt in one hour duration, one unit of energy gets consumed. So, energy meters measure the rapid voltage and currents, calculate their product and give instantaneous power. This power is integrated over a time interval, which gives the energy utilized.

Two Basic Types of Watt-Hour Meter

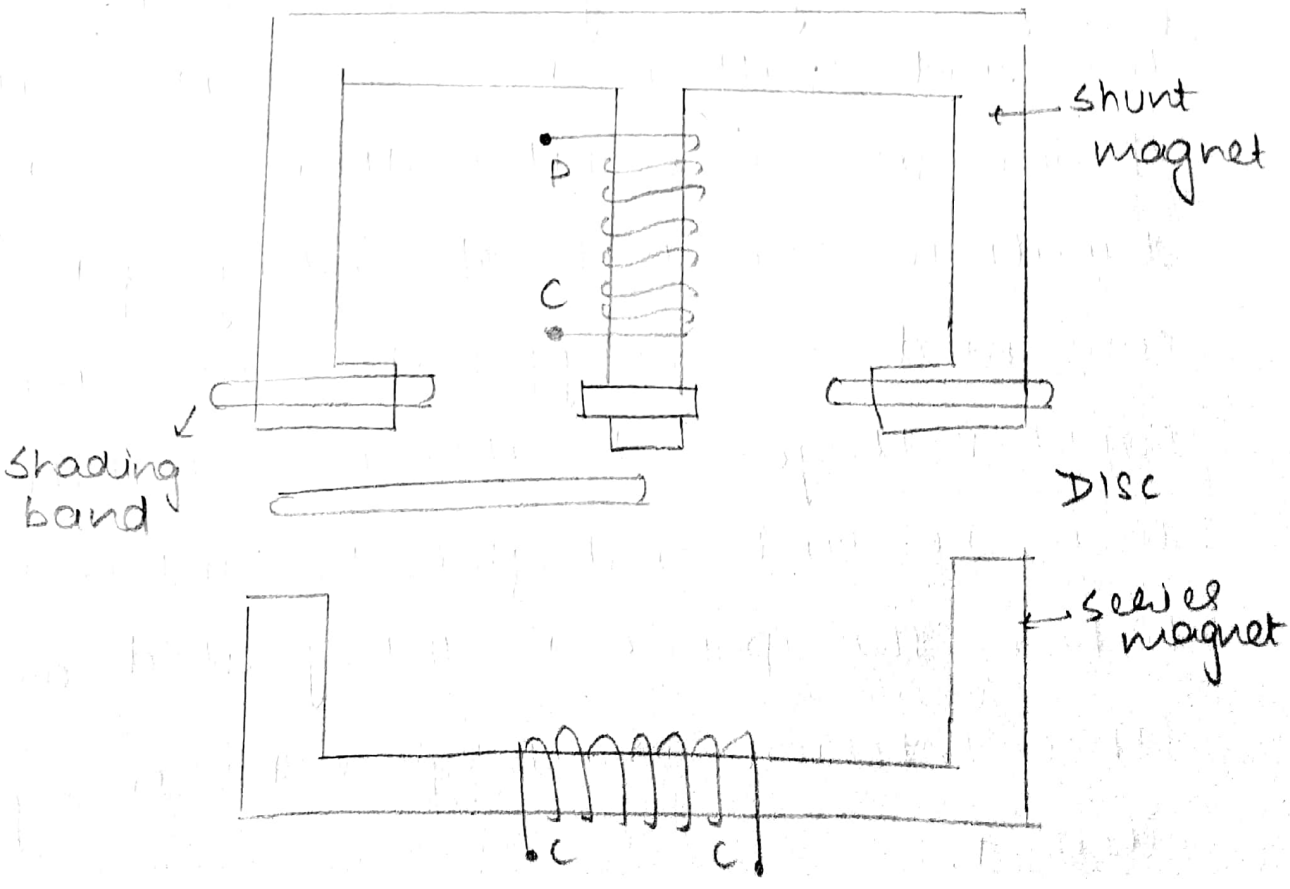
The energy meters are classified into two basic categories, such as:

(I) Electromechanical Type Induction meter

(II) Electronic Energy Meter

Watthour meters are classified into two types by taking the following factors into considerations:

- Types of displays analog or digital electric meter.
- Types of metering points: secondary transmission, grid, local, and primary distribution.



8. Digital Voltmeter

Digital voltmeters are instruments that measure voltage or voltage drop in a circuit. They use solid state components and display values digitally. Typically, digital voltmeters can be used to locate excessive resistance that may indicate an open circuit or ground. They are also used to identify low voltage or voltage drops that may indicate a poor connection. The positive lead is connected to the circuits ground. The digital voltmeters internal resistance is the impedance, which is usually expressed in ohms per volt. This amount is relatively high in order to prevent the device from drawing significant current and disturbing the operation of circuit being tested. The sensitivity of the voltmeter determines the range of voltages that digital voltmeters can measure.

Measurement

Digital voltmeters can measure a range of alternating current (AC) voltages, direct current (DC) voltages, or both AC and DC voltages. Devices typically display between three and seven digits. Some digital voltmeters can capture minimum and maximum voltages called spike readings. Other measure the root mean square (RMS), a range of frequencies, or the signal power in decibels. Digital voltmeters are also used to measure resistance temprature detectors (RTDs), thermo couples, transistors, and diodes.

9. Ammeters.

Digital ammeters are instruments that measure current flow in amperes and display current levels on a digital display. These devices provide information about current drawn and current continuity in order to help users troubleshoot erratic loads and trends. They have both positive and negative leads and features extremely low internal resistance.

Features.

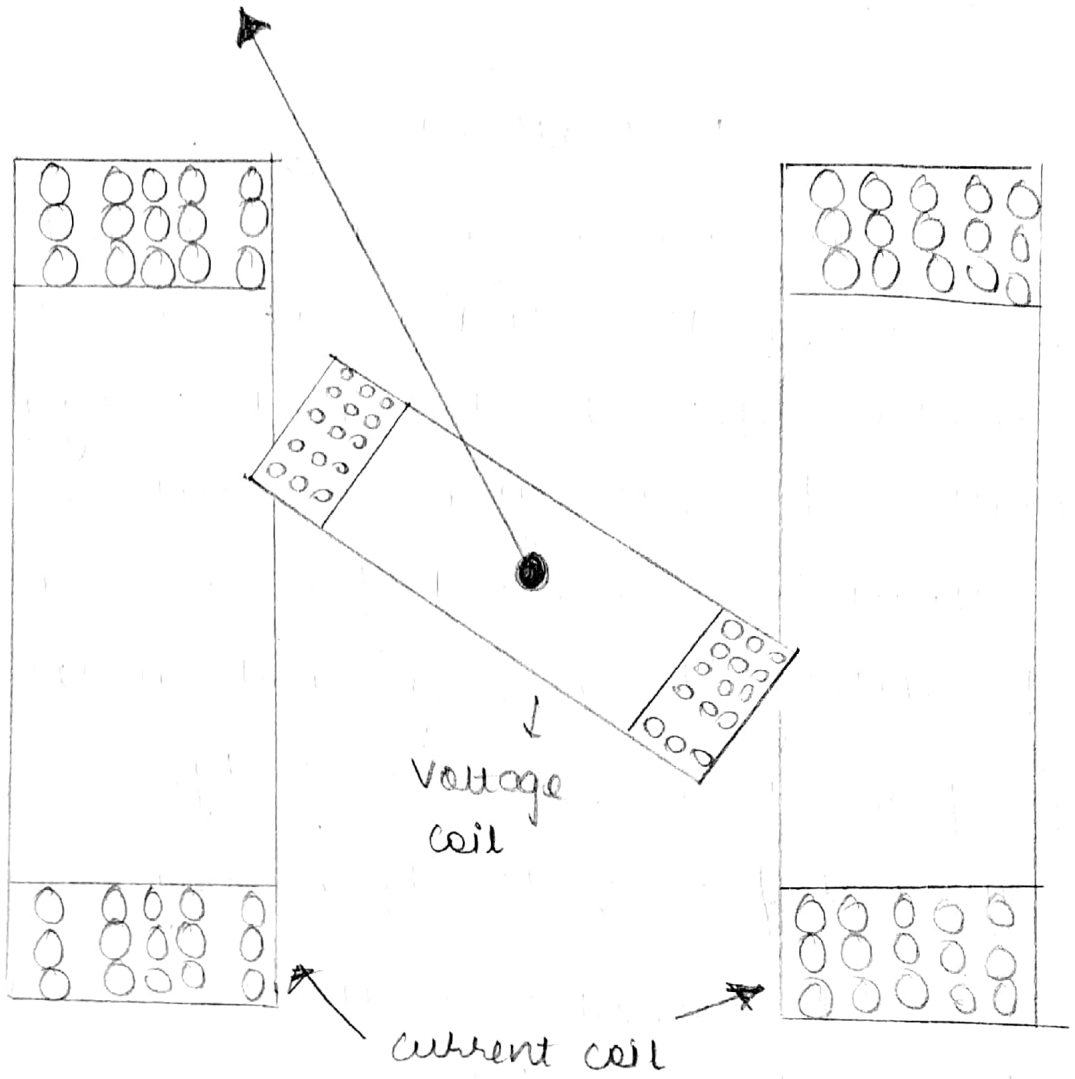
- Adjustable sampling rate - The sampling rate is manually adjustable.
- Alarm LED - Alarm - light-emitting diodes (LED) light when the RMS value is greater than the range. Typically, alarm LEDs light only when the range has been greately exceeded.

- Application software - The device has embedded application software.
- Auto ranging - Auto-ranging devices are self adjusting to offer the best measurement scenario.
- Data acquisition - Devices with data acquisition capabilities have a computer interface and software for uploading data.
- Data storage / logging - Data storage or data logging devices have internal memory for storing data.
- Temprature compensated - Temprature compensated devices are designed to counteract known errors caused by temprature changes.

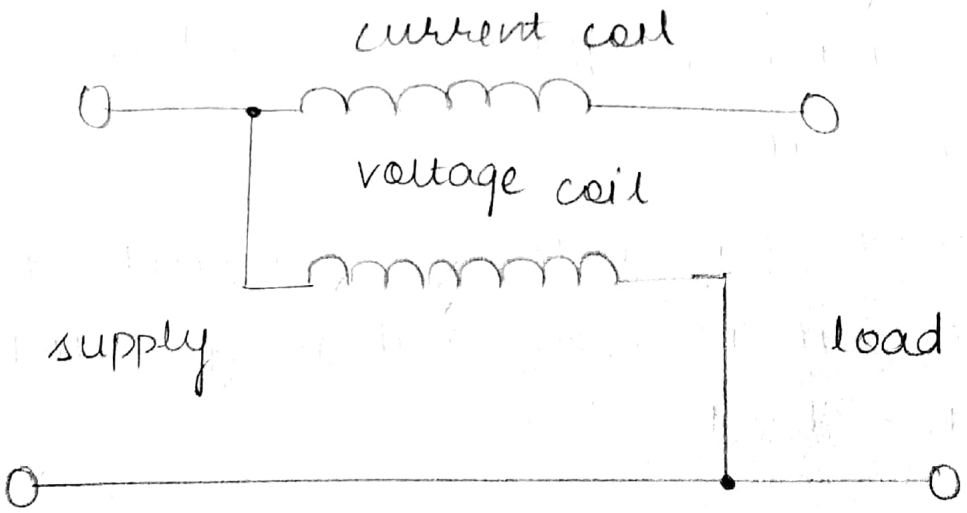
10. Wattmeter.

The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Electromagnetic wattmeters are used for measurement of utility frequency and audio frequency power; other types are required for radio frequency measurement.

- The dynamometer wattmeter works on the motor principle.
- One coil is fixed and is made in two identical parts. It is made upon heavy gauge copper wire. So it has low resistance. This is named as current coil.
- Similar to the voltmeter circuit, the voltage coil is connected in parallel with the load.



Wattmeter construction



manner of connecting the wattmeter into a circuit