Measuring instruments

* Different types of torques

(1) Deflecting Torque (T_D)

- Produce required amount of force in the pointer
- Essential to initiate movement of pointer
- Causes pointer to move from zero position to required value
- To obtain this force in an instrument, different effects of electric current use.

(2) Controlling Torque (T_C)

- It is essential to control the movement of the pointer and to ensure that the magnitude of the deflection of pointer is always the same as given value of quantity to be measured.
- It always acts in opp. direction to deflecting force. And also return the pointer to its initial zero position when the instrument is disconnected from supply.
- It can be produced by any one of the following method.

(a) 1) Gravity Control 2) Spring Control

(3) Damping Torque

Process of controlling movement by producing motions such that it opposes the natural oscillation of system.

Or

This force is necessary to bring the pointer to rest in its final deflected position quickly. Without such damping, the combination of deflecting & controlling torque makes the pointer to oscillate about its final deflected

position for some time. It results in a waste of time while taking reading.

* Moving iron instruments
These are electromagnetic devices used for measuring AC and DC current and voltage. They work on the working principle of moving iron instruments mainly depends on iron movement attracted by magnetic field to it and repulsion among them. Attraction mainly depends on magnetic field strength.

Construction
- Consists of a coil of wire wound on a non conducting former. This coil is connected in series with circuit to be measured
- Soft iron piece is attached such that it can move in/out of the coil
- Pointer is attached to spindle such that it moves with iron
- Controlling torque is provided by spindle.

Working
- When instrument is connected in circuit, a current flows through the coil, it produces a magnetic field around it.
- Magnetic field interacts with iron vane, causing it to rotate
- The amount of rotation of iron vane depends on the strength of magnetic field and current flowing through coil
- The coil then behaves like a magnet and attracts metal piece

- Direction of deflection

Difference b/w attractive and repulsive type of moving coil instruments lies in direction of deflection of iron core. In

Working of Attractive
Attraction
The iron core is attracted towards the fixed coil when the electrical quantity being measured flows through coil. This results in a deflection towards the coil, which is proportional to magnitude of electrical quantity being measured. An attractive type instrument can measure both A.C and D.C quantities

Working of Repulsive
Repulsive
The iron core is repelled away from fixed coil when the electrical quantity being measured flows through the coil. This results in a direction of core away from coil, which is proportional to the magnitude of electrical quantity being measured. Repulsive type instruments are used for measuring A.C quantities only.

→ Disadvantages
1) Non-uniform scale 2) Less sensitive to changes of operating variables
3) Errors in AC (due to change in frequency)
4) High Power consumption

* Moving Coil Instrument Principle
When a current carrying conductor is placed in a magnetic field it operates.

* PMMC
→ Principle -
• It operates on the principle that torque is exerted on the moving coil placed in the magnetic field of permanent magnet. It gives accurate result for DC measurement.

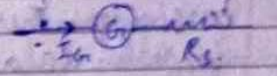
→ Construction
• Moving coil; Coil is wounded with large no. of wire
•• Permanent magnet for creating stationary magnets. Alnico and Alcomax material are used for creating permanent magnet. It creates constant magnetic field. b/w 2 poles of magnet.
••• Pointer - Moving coil is attached to a pointer that moves over a calibrated scale.
• Control Springs - Provides the path to lead current to flow in and out of moving coil.
• The instrument has 2 terminals for connecting it to the circuit being measured.

→ Working
When a current is passed through the coil, it generates a magnetic field that interacts with the permanent magnet's magnetic field, causing the coil to rotate. The amount of rotation is proportional to the strength of current and the pointer moves over the calibrated scale, indicating the measured scale.

Advantage	Disadvantage
Scale is uniform ($\theta \propto I$)	Cannot be used for AC
Low Power consumption	Costlier
No Hysteresis Loss	Ageing of magnet
	Errors due to friction & temp

* Moving coil instrument as ammeter
Connect a low shunt resistance in parallel
$(I_f - I_G) \cdot R_S = I_G R_G$

* Moving coil Instrument as voltmeter
A high series shunt must be connected
$V = I_G (R_G + R_S)$



* Dynamometer Type Wattmeter.
Indicating instrument used to measure power in circuit

→ Principle - These instruments are based on that principle the mechanical force exists b/w current carrying conductors
→ Construction
• Consists of a fixed coil and a moving coil. The fixed coil is split into 2 equal parts which are placed close together and parallel to each other. Moving coil is pivoted in b/w 2 fixed coils. The moving coil is attached to moving system so that under the action of deflecting torque, the pointer moves over the scale

- Controlling torque is provided by 2 springs which also serve the additional purpose of leading the current into and out of moving coil

→ Working

When instrument is connected in the circuit, operating current flows through the coils. Due to this, mechanical force exists between the coil. The result is that moving coil moves the pointer over the scale. The pointer comes to rest at a position where deflecting torque is equal to controlling torque

By reversing the current, field due to fixed coils is reversed as well as the current in the moving coil, so that direction of deflecting torque remains unchange. Therefore such instruments can be used for both dc and ac measurements.

Dynamometer

- Ammeter

$$\theta \propto I^2_{rms}$$

Voltmeter

$$\theta \propto V^2_{rms}$$

→ Advantages of Dynamometer

- Used for both ac & dc measurements.
- free from hysteresis and eddycurrent errors.

→ Disadvantages

- Scale is not uniform.
- Costlier
- Frictional errors which reduce sensitivity.