

# **ELECTRICAL MEASURING INSTRUMENTS AND INSTRUMENTATION**

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# COURSE OBJECTIVES

- *Diploma holders in Electrical Engineering have to work on various jobs in the field as well as in testing laboratories and on control panels, where they perform the duties of installation, operation, maintenance and testing by measuring instruments.*
- *Instruments used to read and observe the general electrical quantities like current, voltage, power, energy, frequency, resistance etc and their wave shapes, have been incorporated in this subject. So the technician will know the construction and use of various types of electrical instruments.*

# SYLLABUS

## ***DETAILED CONTENTS***

### *1. Introduction to Electrical Measuring Instruments: (10 Periods)*

- *1.1 Concept of measurement and instruments*
- *1.2 Concept of measurement of electrical quantities and instruments for their measurements, sources of error.*
- *1.3 Types of electrical measuring instruments – indicating, integrating and recording type instruments. Essentials of indicating instruments – deflecting, controlling and damping torque*

2. *Ammeters and Voltmeters (Moving coil and moving iron type):  
(08 Periods)*
  - *2.1 Concept of ammeter and voltmeters and difference between them*
  - *2.2 Construction and working principles of moving Iron and moving coil instruments*
  - *2.3 Merits and demerits, sources of error and application of these instruments*
  
3. *Wattmeters (Dynamometer Type)  
(04 Periods)*
  - *Construction, working principle, merits and demerits of dynamometer type wattmeter, Digital wattmeters.*

#### 4. *Energymeter*

*(06 Periods)*

##### *a) Induction Type*

*Construction, working principle, merits and demerits of single-phase and three-phase energy meters*

- *Errors and their compensation*
- *Simple numerical problems*
- *Construction and working principle of maximum demand indicators*

*b) Digital energy meter (diagram, construction and application)*

## 5. *Miscellaneous Measuring Instruments:* *(12 Periods)*

- *Construction, working principle and application of Meggar, Earth tester(analog and digital) Multimeter, Frequency meter (dynamometer type) single phase power factor meter (Electrodynamometer type). Working principle of synchroscope and phase sequence indicator, tong tester (Clamp-on meter)*
- *Instrument Transformers: Construction, working and applications*
- *CT*
- *PT*

6. *Electronic Instruments:* *(06 Periods)*

6.1 *Cathode Ray Oscilloscope: Block diagram, working principle of CRO and its various controls. Applications of CRO.*

- *Digital multi-meter (only block diagram) and Applications*

7. *LCR meters.*  
*(04 Periods)*

- *Study of LCR meters and their applications*

8. *Power Measurements in 3-phase circuits by* (06  
*Periods)*
- *Two wattmeter method in balanced and unbalanced circuits and simple problems*
  - *Three wattmeter method*
9. *Transducers :-*  
*(04 Periods)*
- - *Introduction, Types of Transducers (1 phase, 3 phase)*
  - 
  - *Basic concept of pressure measurement, flow measurement, level measurement, displacement measurement using transducers*
10. *Measurement of Temperature*  
*(04 Periods)*
- - *Different types of thermometers, thermocouple, resistance temperature detector and their construction, principle and working. Thermal Imager Camera (Concept)*

# LIST OF PRACTICALS

- *Use of analog and digital multimeter for measurement of voltage, current (A.C/D.C) and resistance*
- *Measurement of pressure by using LVDT*
- *To measure the value of earth resistance using earth tester.*
- *To measure power, power factor in a single-phase circuit, using wattmeter and power factor meter and to verify results with calculations.*
- *Measurement of power and power factor of a three-phase balanced load by two wattmeter method.*
- *Measurement of voltage and frequency of a sinusoidal signal using CRO and draw wave shape of signal.*
- *Measurement of power in a 3 phase circuit using CT, PT and 3-phase wattmeter.*
- *Use of LCR meter for measuring inductance, capacitance and resistance.*
- *To record all electrical quantities from the meters installed in the institution premises.*
- *To measure Energy at different Loads using Single Phase Digital Energy meter*
- *Measurement of temperature by using thermister/Thermal Imager*
- *Calibration of single phase and three-phase energy meter*

# TYPES OF INSTRUMENTS

- ***Absolute Measuring Instruments***

*These instruments give output in terms of physical constant of the instruments. For example Rayleigh's current balance and Tangent galvanometer are absolute instruments.*

- ***Secondary Measuring Instruments***

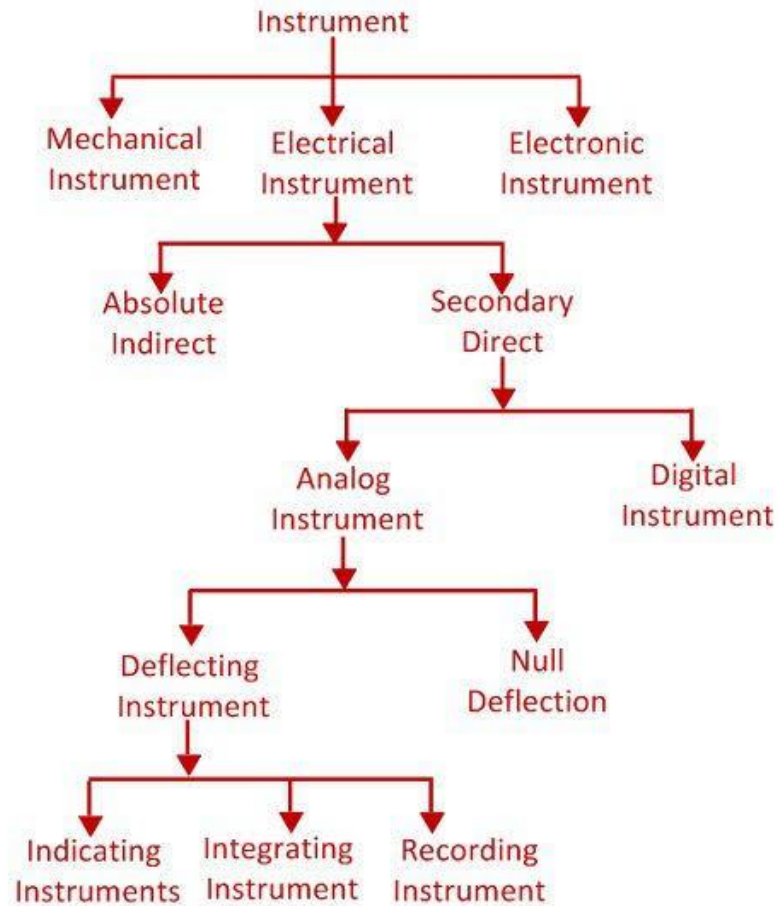
- *These instruments are constructed with the help of absolute instruments. Secondary instruments are calibrated by comparison with absolute instruments. These are more frequently used in measurement of the quantities as compared to absolute instruments, as working with absolute instruments is time consuming.*

# CATHODE RAY OSCILLOSCOPE



- The **electrical instrument** is used for measuring **electrical** quantities like current, voltage, power, etc. The ammeter, voltmeter, wattmeter are the examples of the **electrical** measuring **instrument**. The ammeter measures the current in amps; voltmeter measures voltage and Wattmeter are used for measuring the power.

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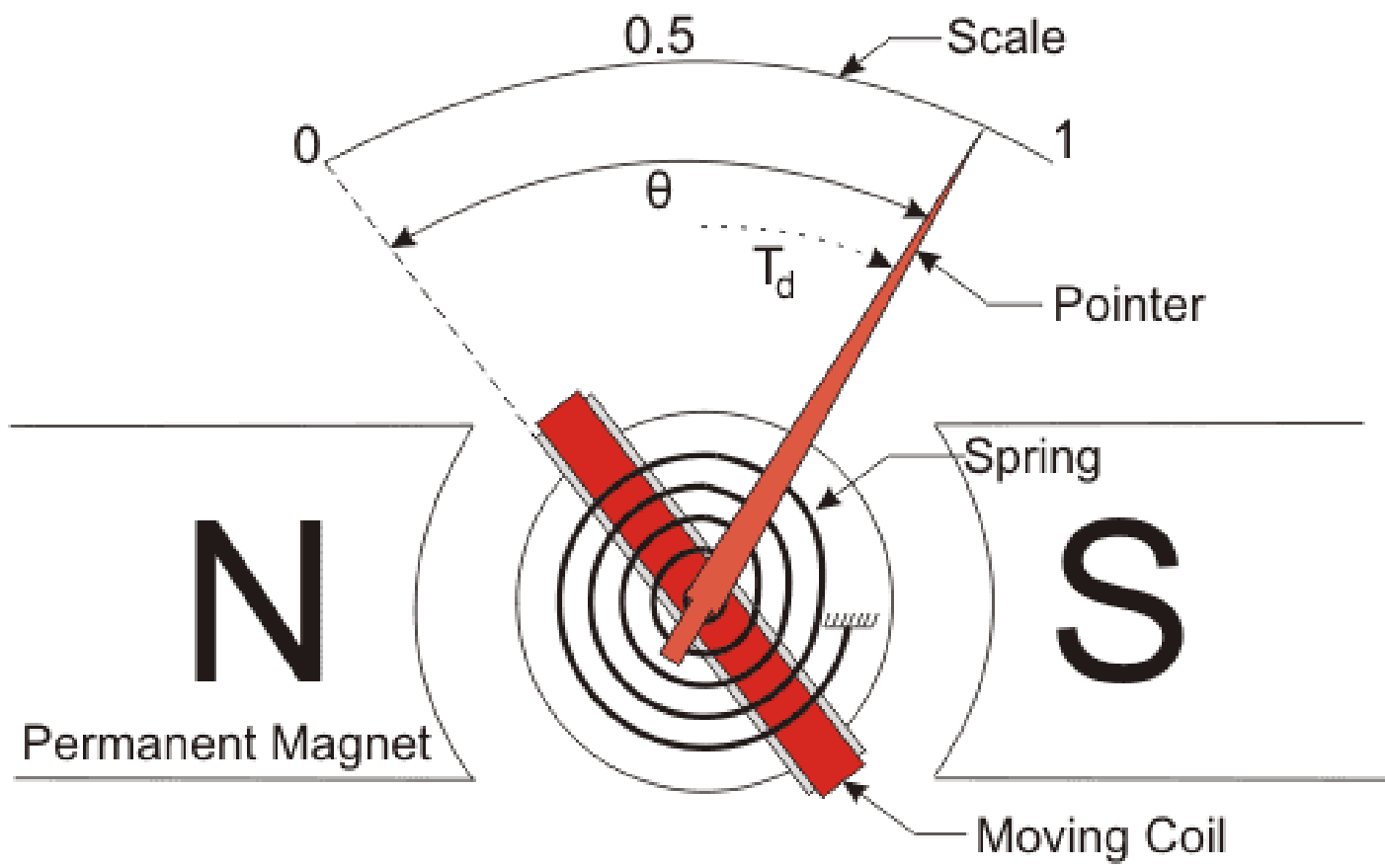


# MULTIMETER



# Deflection Type Instruments

- *In these types of instruments, pointer of the electrical measuring instrument deflects to measure the quantity. The value of the quantity can be measured by measuring the net deflection of the pointer from its initial position*



# MOVING COIL INSTRUMENT

*The diagram shown has two permanent magnets which are called the stationary part of the instrument and the moving part which is between the two permanent magnets that consists of pointer. The deflection of the moving coil is directly proportion to the current.*

*Thus the torque is proportional to the current which is given by the expression  $T_d = K.I$ , where  $T_d$  is the deflecting torque.  $K$  is proportionality constant which depends upon the strength of the magnetic field and the number of turns in the coil. The pointer deflects between the two opposite forces produced by the spring and the magnets.*

# Static Characteristics

*In these type of characteristics measurement of quantities are either constant or vary slowly with the time. Few main static characteristics are written below:*

- **Accuracy:**

*It is desirable quality in measurement. It is defined as the degree of the closeness with which instrument reading approaches the true value of the quantity being measured. Accuracy can be expressed in three ways*

- *Point accuracy*
- *Accuracy as the percentage of scale of range*
- *Accuracy as percentage of true value.*

**Sensitivity:**

*It is also desirable quality in the measurement. It is defined as the ratio of the magnitude response of the output signal to the magnitude response of the input signal.*

**Reproducibility:**

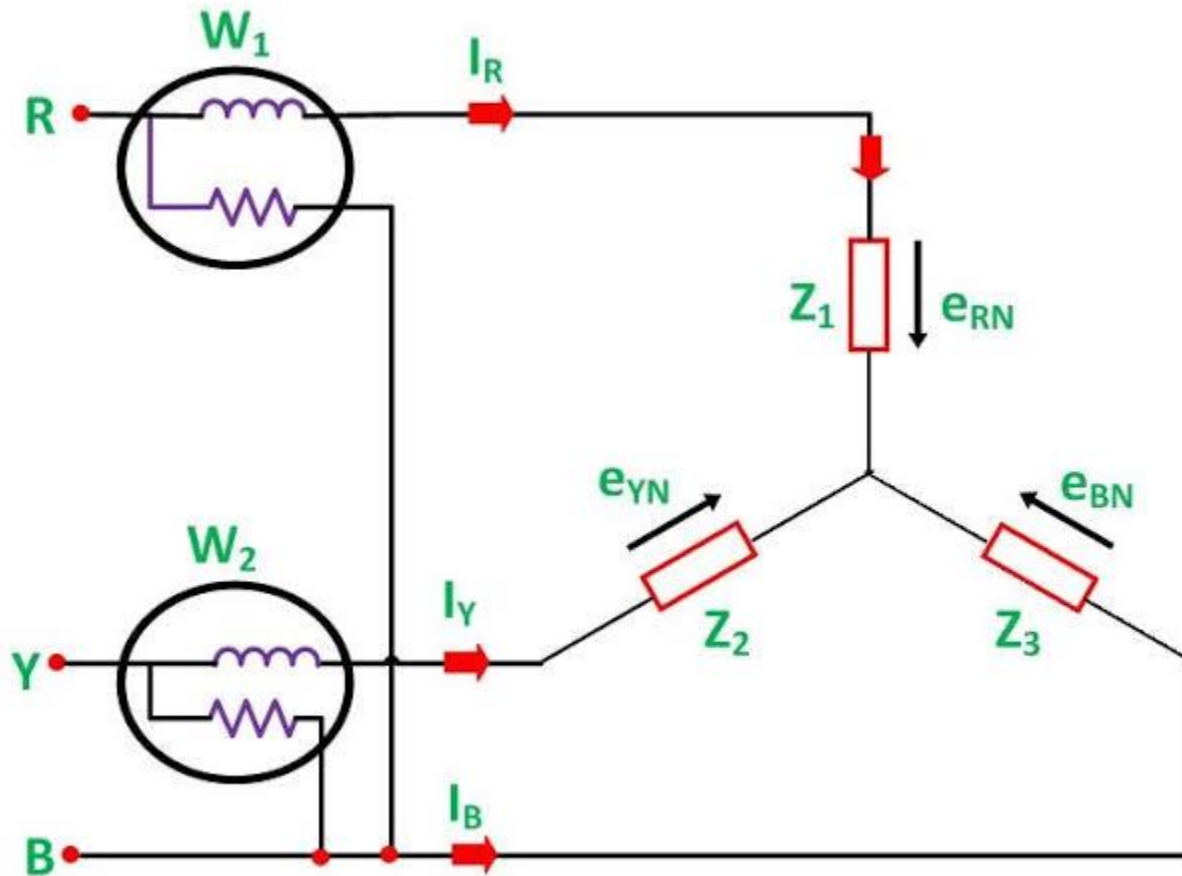
*It is again a desirable quality. It is defined as the degree of the closeness with which a given quantity may be repeatedly measured. High value of reproducibility means low value of drift. Drift are of three types*

- Zero drift
- Span drift
- Zonal drift

**Dynamic Characteristics**

*These characteristics are related with the rapidly changing quantities therefore in order to understand these types of characteristics we are required to study the dynamic relations between the input and the output.*

# TWO WATTMETER METHOD



# MEANS OF ASSESSMENT

- *Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making*
- *Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce*

# BIBLIOGRAPHY

## RECOMMENDED BOOKS

- *Electrical Measurements and Measuring Instruments by Golding and Widdis; Wheeler Publishing House, New Delhi*
- *Electrical Measurements and Measuring Instruments by SK Sahdev, Uneek International Publications, Jalandhar*
- *A Course in Electrical Measurement and Measuring Instruments by AK Sawhney and PL Bhatia; Dhanpat Rai and Sons, New Delhi*
- *Electric Instruments by D. Cooper*
- *Eperiments in Basic Electrical Engineering by SK Bhattacharya and KM Rastogi, New Age International (P) Ltd., Publishers, New Delhi*
- *Electronics Instrumentation by Umesh Sinha, Satya Publication, New Delhi*
- *Basic Electrical Measurements by Melville B. Staut.*
- *Electrical Measurement and Measuring Instruments by JB Gupta, SK Kataria and Sons, New Delhi*
- *Electrical Measurement and Measuring Instruments by ML Anand, SK Kataria and Sons, New Delhi*
- *e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.*