Department of Electronics and Communication Engineering

Hand Out

Subject Name: Electronic Measurements and Instrumentation

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Unit – I: Introduction to Measuring Instruments

Important Points / Definitions:

- Instrument is a device or mechanism used to determine the present value of the quantity under measurement
- Measurement is the process of determining the amount , degree or capacity by comparison with the accepted standards
- Resolution is the smallest change in a measured variable to which an instrument will respond
- Accuracy is the closeness with which an instrument measurement approaches the true value Of the variable being measured
- Precision is a measure of the consistency of instrument for a given value of input
- Sensitivity is the ratio of change in output of the instrument to a change of input or measured variable
- The static error of a measuring instrument is the numerical difference between the true value of a quantity and its value as obtained by measurement
- Fidelity is the degree to which an instrument indicates the changes in the measured variable without dynamic Error
- Dynamic Error is the difference between the true value of a quantity changing with time and The value indicated by the instrument
- Permanent magnetic moving coil (PMMC) can be used only for DC measurements
- The Torque developed in the PMMC is given by $\tau=BAIN$ where B is flux density in air gap, A is Effective coil Area, I is current in the coil, N is number of turns in the coil
- Moving Iron instruments are classified into repulsion and attraction type
- The current Range of the DC Ammeter can be extended by multiple shunts and a range Switch
- A DC voltmeter can be converted into a multi range voltmeter by connecting a number of series Resistors (multipliers) and a range switch
- The true RMS responding voltmeter produces a meter deflection by sensing the heating power of the waveform
- A multimeter also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that measures voltage, current, and resistance

Questions

1. Define PMMC and give a classification of Ammeters.
2. Explain the following terms in detail (i) Accuracy (ii) Resolution (iii) Precision

(iv) Expected value
3. Discuss the following characteristics in detail (i) speed of response (ii) Fidelity

(iii) Lag and Dynamic error.
4. List out different AC voltmeters and explain the working of any one voltmeter in detail.
5. Draw the series type Ohmmeter and explain its operation
6. Summarize the features of the Multimeter.
7. Compare various Ohm-Meters.
8. Summarize various Meter protection techniques.

Fill in the blanks / choose the Best:

1. A digital voltmeter has a readout range from 0 t0 999 counts the resolution is **1 mv**
2. **Accuracy** refers to the degree of closeness or conformity to the true value of quantity under measurement
3. **Precision** is defined as the ability of the instrument to reproduce a certain set of readings within a given accuracy
4. **Dead zone** is defined as the largest change in input quantity for which there is no output for the instrument
5. **Systematic errors** type of errors are due to shortcomings of the instrument like detective or worn parts
6. **Fidelity** is defined as the degree to which the instrument indicates the change in the measured without dynamic error
7. A set of readings has a wide range and therefore it has **low precision**
8. A. 1mA ammeter has a resistance of 100 O. It is to be converted to 1A Ammeter. The value of shunt resistance is **0.1001 Ω**
9. An 0-10 A ammeter has a guaranteed accuracy of 1 percent of full scale deflection. The limiting error while reading 2.5 A is **9. 4%**
10. In a d'Arsonval galvanometer an iron core is usually used between the permanent magnet pole faces. This is used for **flux density** in the air gap becomes high there by a large deflecting torque is produced.
11. The smallest measurable input change is called **Resolution.**
12. **Systematic** type of errors is due to shortcomings of the instrument like detective or worn Parts.

Unit – IV: Bridges & Physical Measurement of Parameters

Important Points / Definitions:

- Bridge circuits are the instruments making comparisons measurements, are widely used to measure resistance, inductance, capacitance and impedance.
- $R_1R_4 = R_2R_3$, states the Wheatstone bridge balancing condition and can be used to compute the value of unknown resistor
- Kelvin Bridge can measure resistors within the range of 1 to approximately 1 with high degree of accuracy.
- Maxwell Bridge can be used to measure unknown inductances in terms of calibrated resistance and capacitance.
- The measurement of force or pressure can be done by converting the applied force or pressure into displacement by elastic elements such as diaphragm, capsule, bellows or bourdon tube
- Electromagnetic Flow meter is suitable for measurement of slurries, sludge and any electrical conducting liquid.
- The voltage induced across electrodes of Electromagnetic Flow meter is E=Blv volts
- The liquid level in a container can be measured with ultrasonic method and by using float method
- Resistance temperature detector (RTD) devices are conductors used for temperature sensing.
- Humidity is the amount of water vapour in the air
- Humidity can be expressed as Absolute Humidity or Relative Humidity
- The instrument used for measuring humidity is the Electrical Hygrometer
- Data Acquisition System converts the signal into a digital format acceptable by a computer

 Data Acquisition Systems Process, analyze, store, and display the acquired data with the help of a computer

 Signal conditioning circuits improve the quality of signals generated by transducers before they are converted into digital signals

 Data Acquisition System are classified into Analog and Digital types

Questions

1. With the help of a neat sketch explain the principle and working of Electromagnetic Flow meter. What are the advantages and Limitations of this Method?
2. What are the two types of anemometer available for liquid flow measurement? Explain the principle and operation of Hotwire Anemometer.
3. Define Humidity and give a classification. Explain the procedure for the measurement of humidity.
4. Explain the concept of Data acquisition systems in detail.
5. Explain the operation of Maxwell's Bridge and derive the condition for balance of a Bridge.
6. Draw the circuit of Wien Bridge and derive the expression for bridge balance.

Fill in the blanks / choose the Best:

1. An AC bridge in its basic form consists of **four arms, a source of excitation and balance detector.**
2. A suspension type galvanometer having a sensitivity 0.5μA per scale division is used to Measure **Dc resistance.**
3. The advantage of Hay's bridge over Maxwell's inductance-capacitance bridge is **it can be used for measurement of inductance of high Q coils.**
4. **Wien's** bridge is used in harmonic distortion analyzer.
5. In the Wien's bridge, to balance the harmonics **A filter is connected in series with the null detector** is used.
6. To cover the entire range of humidity, **Aluminium oxide Hygrometer** device is used?
7. The disadvantage of Velocity measurement using Tachometer generators is **Brushes produce an appreciable error .**

8. The most commonly used transducer for the measurement of liner velocity is E**lectro-magnetic transducer.**
9. **Accelerometer** is used to measure the acceleration.
10. Digital data acquisition systems are not used when **Wide frequency width is required**.

Unit – V: Transducers

Important Points / Definitions:

 A transducer is a device that converts the physical quantity into a proportional electrical quantity such as voltage or current.

 Transducer contains two parts that are sensing element and transduction element.

 The transducers can be classified into Active and passive transducers

 Active transducers do not need any external source of power for their operation.

 Passive Transducers need external source of power for their operation, they are not self generating type transducers.

 Capacitive transduction transducers convert the measurand into a change in the capacitance.

 Inductive transducers converts the measurand into a change in the self inductance of a coil

 Piezoelectric transducers converts the measurand into a change in electrostatic charge or voltage generated by crystals when mechanically stressed

 The strain gauge is a passive, resistive transducer which converts the mechanical elongation and compression into a resistance change

 The types of strain gauges are Wire gauge (Unbounded, Bonded, Foil)type and Semiconductor gauge

 Resistance Thermometer works on the principle that resistance of metal increases with increases in temperature.

 Thermistors are temperature dependent resistors, they are made of semiconductor material which have negative temperature coefficient of resistivity

 A thermocouple is an electrical device consisting of two dissimilar electrical conductors which produces a temperature-dependent voltage as a result of the thermoelectric effect

 LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (LVDT) is a transducer which converts the physical motion into the change in inductance.

 When the core is exactly at the centre of the coil in a LVDT the flux linked to both secondary windings will be equal. Output voltage eo is zero.

Questions

1. Briefly explain the working principles and measurement of force by any two nonelectric techniques
2. Derive the expression for Gauge factor of a strain Gauge.
3. List out differences between active and passive transducer in detail
4. Explain piezo electric effect with a neat diagram.
5. Draw the Linear variable differential Transducer and explain its operation in detail.
6. Define LVDT? Explain its Applications?

Fill in the blanks / choose the Best:

1. The dynamic characteristics of capacitive transducers are similar to those of **High pass filters**.
2. The sensitivity of the capacitive transducer can be increased by making the distance between the plates extremely **small**.
3. Air cored inductive transducers are suitable for **Higher frequencies**.
4. The size of air cored inductive transducers as compared with the iron cored transducers is **larger.**
5. Capacitive transducers are normally used for **Dynamic measurements**.
6. Capacitive transducers can be used for measurement of liquid level. The principle of
7. Operation used in this case is **Change of dielectric strength**.
8. In semiconductor strain gauges, when tensile strain is applied. **Resistance increases in P type materials.**
9. Metal foil gauges use fat end turns in order to **Reduce transverse sensitivity**.
10. The resistive strain gauges are known as piezo resistive gauges because there is a change in the value of resistivity of the conductor when it is **stretched or Compressed.**
11. A resistance wire strain gauge uses a soft iron wire of small diameter. The gauge factor is +4.2. Neglecting the piezo resistive effects, the Poisson's ratio is **8.4.**