QUIZ – ANSWER KEY

QUIZ NO: 98

TOPIC: ELECTRICAL ENGINEERING

DATE: 11/08/2022

1. In series type ohmmeter, full-scale deflection current indicator is marked ?

   [A] Zero

   [B] Infinite

   [C] 100 ohm

   [D] 1 Megaohm

   Answer: A

   Explanation:-

   Series Type Ohmmeter

   Instead of measuring both voltage and current, many instruments keep one of the two quantities constant. Thus the measurement of other quantity is nothing but proportional to the value of the resistance. If the current is kept constant, a voltmeter reading across the resistance is directly proportional to the value of the resistance. This is the principle of the Ohmmeter. Similarly, if the voltage is kept constant, an ammeter in series will have deflection proportions to the conductance but the meter can be calibrated in terms of the resistance.

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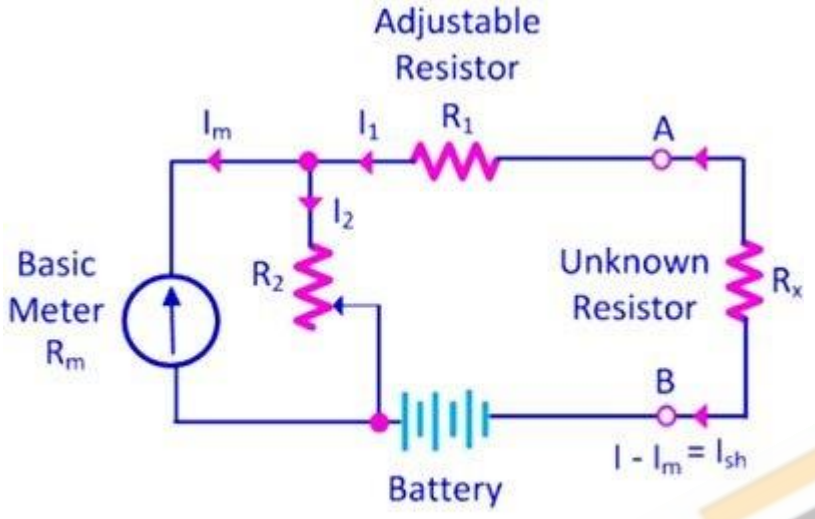

Series Type Ohmmeter

A series type ohmmeter consists of a deflecting meter in series with a resistance R_1 and a battery which is connected to the terminals A-B, across wh the unknown resistance is connected.

R_1 = Current Limiting Resistance

R_2 = Zero adjust Resistance

R_m = Meter Resistance

R_X = Unknown Resistance

V = Battery Voltage

The current flowing through the meter depends on the magnitude of the unknown resistance. Thus the meter deflection is proportional to the value of He resistance. Hence Be meter scale should be calibrated accurately.

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When the unknown resistor $R_x = 0$ (terminals A and B shorted), maximum current flows in the circuit. Under this condition, the shunt resistor R_2, is adjusted until the movement indicates full-scale current (I_{fsd}). The full-scale current position of the pointer is marked '0Ω" on the scale.

Similarly, when $R_X = 0$ (terminals A and B open), the current in the circuit drops to zero and the movement indicates zero current, which is then marked "∞" on the scale.

By connecting different known resistances across the terminals A-B, intermediate markings can be done.

As current is inversely proportional to the resistance, the scale is marked from ∞ to 0, rather than 0 to ∞. This is shown in Fig.

Scale of Series type Ohmmeter

2. For the measure of voltage and current in the ratio frequency range, a suitable instrument is ?

   [A] Moving iron type

   [B] Moving coil type

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[C] Electrothermic type

[D] Electrostatic type

Answer: C

Explanation:-

Electrothermic type Instrument

The principle of operation of those instruments is based on the properties of certain circuit elements which gets heated when current flows through them. The average effect is dependent upon the mean square value of current and therefore, these instruments are used to indicate the true r.m.s. values. Consequently, the reading obtained is virtually free from frequency and waveform errors and also errors due to stray magnetic fields. The accuracy is equally good on a.c. as well as d.c. circuits.

The main significance of such an instrument is that they can be used to measure current at very high frequencies without many errors. So obviously these instruments are used for current measurement at the frequency well above the range of moving Iron and electrodynamometer type Instrument. These instruments can be used for Precision voltage measurement at moderate frequencies.

The electrothermic instruments are classified into the following three categories:

(i) Hot-wire instruments

(ii) Thermocouple instruments

(iii) Bolometers

Hot-wire instruments

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- Thermoelectric element used in hot wire type instruments is made up of platinum-iridium.
- The sensitivity of electrothermic instruments is higher than electrodynamometer type instruments.

Advantages and Disadvantages—

(i) Not affected by frequency hence can be used at the higher frequency (more than 50 MHz), these indicate RMS value irrespective of the waveform.

(ii) Not affected by the magnetic field.

(iii) Can be used AC & DC measurements.

(iv) Measurement in an electrothermic instrument is independent of the waveform.

(v) The instruments have disadvantages like instability due to stretching of wire, sluggish response, high power consumption and inability to withstand overloads and mechanical shocks.

Thermocouple Type instruments

- These instruments are generally used upto 500 V and at the frequency more than 50 MHz. At frequencies more than 50 MHz the skin effect is dominant and can cause an error. But this can be minimized by using Tubular Conductor. This is preferable for current I > 3A.
- The thermoelectric instruments give the same calibration for AC & DC, therefore, these instruments can be calibrated by DC and can be used for AC measurement that is why these instruments are also called transfer instruments.
- At low frequencies voltmeter act as a precision instrument.

Bolometer

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Such an instrument is based on the fact that when current passes through the circuit element, it gets heated. Due to this dimension changes and resistance of the circuit elements changes.

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3. Which of the following meters will require the smallest shunt resistance ?

[A] 0-10 mA

[B] 0-100 mA

[C] 0-1 mA

[D] 0-10 A

Answer: D

Explanation:-

According to the Ohm's law;

I = V/R

So, more the value of current the value of resistance will be less therefore 0-10 A current will require low shunt resistance.

4. A permanent magnet moving coil type ammeter and a moving iron type ammeter is connected in series with the output of a half wave rectifier. If the moving iron type instrument reads 5-ampere magnet moving coil type instrument is likely to be ?

[A] Zero

[B] 5 A

[C] 3.18 A

[D] 2.5 A

Answer: C

Explanation:-

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- For half-wave rectifier
- $I_{DC} = I_{Peak}/\pi$
- $I_{RMS} = I_{Peak}/2$
- $I_{DC} = 2 \times I_{RMS} / \pi$
- Where
- I_{DC} = DC output current
- I_{Peak} = Peak value of the current
- I_{RMS} = output current of root mean square value = 5 A
- ∴ PMMC Reading would be
- **$I_{DC} = (2 \times 5) / \pi = 3.18$ A**

5. In shunt type ohmmeter, full-scale deflection current indicator is marked ?

[A] Zero

[B] Infinite

[C] 100 mΩ

[D] 100 MΩ

Answer: B

Explanation:-

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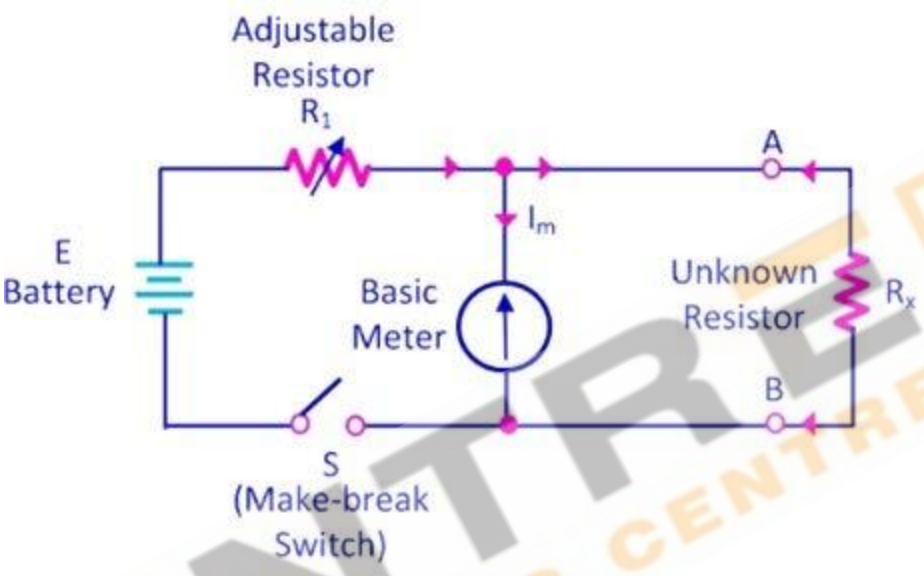
The shunt-type ohmmeter is used for measuring low values of resistance. It operates on the same basic principle as an ammeter shunt. When using a shunt-type ohmmeter, place the unknown value of resistance in parallel with the meter movement. This causes part of the circuit current to bypass the meter.



Shunt Type Ohmmeter

The shunt type ohmmeter consists of a battery in series with an adjustable resistance R_1 and a meter movement.

The switch is provided to disconnect the battery when the instrument is not in use. The unknown resistance is connected in parallel with the meter hence the name given to the instrument is shunt type ohmmeter.

When the terminals A-B are shorted then the meter gets bypassed by the short circuit. Hence entire current flows through the short circuit and meter current is zero. This pointer position is marked as zero and the corresponding $\mathbf{R_x = 0}$ as terminals A-B are shorted.

When the terminals A-B are opened i.e. $\mathbf{R_x = \infty}$ then the entire current flows through the meter hence pointer deflects to the maximum. The resistance R_1 is

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then adjusted such that current through the meter is its full-scale deflection current. This position of the pointer is marked as ∞.

Thus the scale is marked form **0 to ∞** and not reversely from **∞ to 0** as in the case of the series ohmmeter.

6. Advantage of LVDT ?

[A] 0.05% linearity and finite resolution

[B] High output and high sensitivity

[C] Rugged and less friction

[D] All of the above

Answer: D

Explanation:-

LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (LVDT)

This is the most widely used inductive transducer for translating linear motion into an electrical signal. As we know that displacement is a vector quantity representing a change in position of a body or a point with respect to a reference. It can be linear or angular (rotational) motion. With the help of the displacement transducer, many other quantities, such as force, stress, pressure, velocity, and acceleration can be found.

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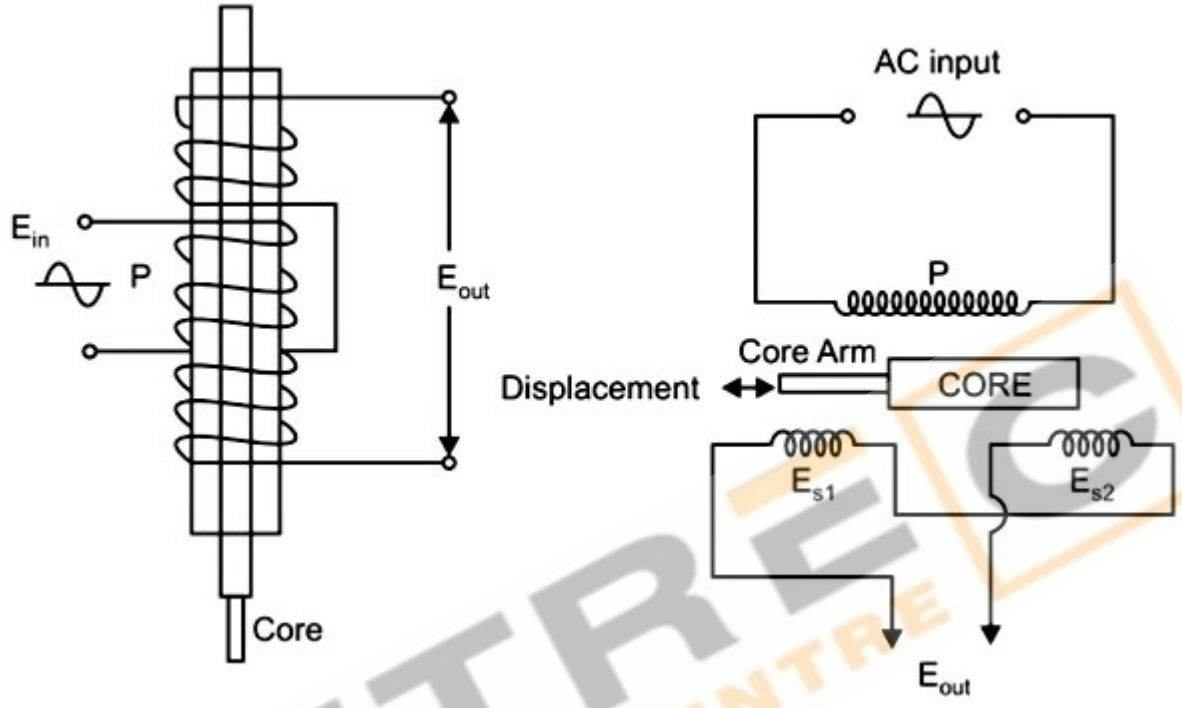

The main electrical displacement transducers work on the principle of

Variable resistance: transducer is a strain gauge.

Variable inductance: transducer is a linear variable differential transformer

Variable capacitance: transducer is a parallel plate capacitor with a variable gap

Synchros and resolvers: used to measure angular displacement

Advantages of LVDT:

1. **Linearity:** The output voltage of LVDT is almost linear for displacement up to 5mm.
2. **High Output:** The LVDT gives reasonably high output and hence requires less amplification.

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3. **High Sensitivity:** The LVDT has a high sensitivity of about 300 mV/mm. i.e., 1mm displacement of the care produces an output voltage of 300 mV.
4. **Ruggedness:** The LVDT is mechanically rugged and can withstand mechanical shock and vibrations.
5. **Less friction:** Since there is no sliding contact, the friction is very less.
6. **Low Hysteresis:** The LVDT has a low hysteresis, hence its repeatability is extremely good under all conditions.
7. **Low Power Consumption:** Most LVDTs consume Less than the watt of power. The LVDT transducers are small, simple and light in weight. They are stable and easy to align and maintain.

Disadvantages of LVDT

1. Comparatively, large displacement is necessary for appreciable differential output.
2. They are sensitive to stray magnetic fields. However, this interference can be reduced by shielding.
3. The temperature effects transducers.
4. The dynamic response is limited.

Applications of LVDT

1. The LVDT can be used in all applications where displacement ranging from fractions of a few mm to a few cms have to be measured.

2. Acting as a secondary transducer, LVDT can be used as a device to measure force, weight & pressure etc.

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7. Some substance generates the voltage when they are subjected to mechanical forces or stress along specific planes. Such substance is known as_____?

   [A] Piezoelectric

   [B] Thermo-electric

   [C] Photo-electric

   [D] Radio-active

   Answer: A

   Explanation:-

   Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. One of the unique characteristics of the piezoelectric effect is that it is reversible, meaning that materials exhibiting the direct piezoelectric effect (the generation of electricity when stress is applied) also exhibit the converse piezoelectric effect (the generation of stress when an electric field is applied).

   The most used piezoelectric materials are PZT, a ceramic containing lead titanate and lead zirconate and PZLT, a ceramic of lead-lanthanum-zirconate-titanate.

   Natural piezoelectric materials such as quartz (SiO_2) and Rochelle salt ($NaKC_4H_4O_6–_4H_2O$) are also used for piezoelectric transducers.

8. Which of the following instrument can be used for the measurement of a temperature above 1500°K ?

   [A] Mercury thermometer

   [B] Gas Thermometer

   [C] Thermoelectric pyrometer

   [D] Any of the above

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Answer: C

Explanation:-

A pyrometer is a device for measuring very high temperatures and uses the principle that all substances emit radiant energy when hot, the rate of emission depending on their temperature. The measurement of thermal radiation is, therefore, a convenient method of determining the temperature of hot sources and is particularly useful in industrial processes. There is two main type of pyrometer, namely the total radiation pyrometer and the optical pyrometer.

Pyrometers are very convenient instruments since they can be used as a safe and comfortable distance from the hot source. Thus applications of pyrometer are found in measuring the temperature of molten metals, the interiors of furnaces or the interiors of volcanoes. Total radiation pyrometers can also b used in conjunction with devices that record an control temperature continuously.

Total radiation pyrometers are used to measure temperature in the range 700°C to 2000°C.

Optical pyrometers may be used to measure temperatures up to, and even in excess of, 3000°C.

Measurement of temperature using the thermometer

1. **Liquid thermometer:-**
    a. **Low temperature:** as low as −30°C (freezing point of mercury is −39°C) can be measured using mercury and as low as -100°C can be measured by using alcohol (Remains liquid upto-130°C) in glass thermometers.
    b. **High temperature:** A mercury thermometer (boiling point of mercury is 357°C) can be used to measure temperature upto 300°C. The range can be increased to 600°C by filling the space above mercury with some inert gas. A gallium

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boiling point 1700°C thermometer made of quartz can be conveniently used for measurement of temperature upto 1000°C.

2. **Gas thermometers**
    a. **Low temperature:** For measurements of low temperatures upto −250°C constant volume hydrogen thermometers are used and for measure merits below -250°C upto -270°C hydrogen is replaced by Helium. The Helium. at the pressure below its vapor pressure can be used to measure temperature down to 1 K.
    b. **High temperature:** For high-temperature measurement upto 500°C the standard hydrogen gas thermometer with platinum-iridium bulb can be used, and for the temperature upto 1100°C porcelain bulb is used. Using nitrogen in place of hydrogen in Rhodium bulb, the temperature as high as 1600°C can be measured.
3. **Resistance thermometers**
    a. **Low-temperature range:** The platinum resistance thermometer is suitable for measurement upto -190°C. A lead thermometer may be used to measure temperature as low as -250°C and below these temperature constant and manganin thermometers are used. Phosphor bronze can be used to measure still lower temperatures with great accuracy.
    b. **High-temperature range:** Platinum resistance thermometers can be used to measure temperature upto 700°C with the coil enclosed in the glass bulb and lead made of copper and upto 1300°C with the coil enclosed in porcelain with platinum leads.
4. **Thermoelectric-thermometer**
    a. **Low-temperature measurement:** Thermocouples of Iron-constantan and copper constantan are used to measure temperature as low as 18 K and gold-platinum and silver platinum thermocouples are used to measure below 18 K with high accuracy.

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b. **High-temperature measurement:-** Iron constantan or copper constants are used to measure temperate upto 300°C and thermocouples of nickel-iron are used to measure temperature opts 600°C. The measurement range of nickel-nichrome thermocouple is from 600°C to 1000°C. Between 1000°C and 1600°C Platonism Rhodium thermocouple is used.

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9. Which of the following quantities cannot be measured by a load cell ?

[A] Pressure

[B] Temperature

[C] Level

[D] All of the above

Answer: B

Explanation:-

- Load cells can measure tension, compression, or shear.
- Tension cells are used for measurement of a straight-line force 'pulling apart' along a single axis; typically annotated as the positive force.
- Compression tension cells are used for measurement of a straight-line force 'pushing together' along a single axis; typically annotated as the negative force.
- Shear is induced by tension or compression along offset axes. Most load cells actually measure the displacement of a structural element to determine force.
- The force is associated with a deflection as a result of calibration.
- There are many form factors or packages to choose from—S-beam, pancake, donut or washer, plate or platform, bolt, link, miniature, cantilever, canister, load pin, rod end, and tank weighing.
- Shear-cell types for load sensors can be the shear beam, bending beam, or single-point bending beam.
- The most common sensor technologies are piezoelectric and strain gauge.
- For piezoelectric devices, a piezoelectric material is compressed and generates a charge that is conditioned by a charge amplifier.
- For strain gauge devices, strain gauges (strain-sensitive variable resistors) are bonded to parts of the structure that deform when making the measurement.
- These strain gauges are typically used as elements in a Wheatstone bridge circuit, which is used to make the measurement.
- Strain gauges typically require an excitation voltage and provide output sensitivity proportional to that excitation.

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10. The accuracy of a 0-100 mV voltmeter is ±5%. A full-scale reading of 100 mV may be due to a voltage of ?

[A] 105 mV or 95 mV
[B] 110 mV or 90 mV
[C] 100 mV
[D] 90 mV

Answer: A

Explanation:-

The limiting error at full scale is;

$\delta E = \pm 5\%$ of 100

$\delta E = \pm 5mv$

The actual value of limiting error can be expressed as;

$Ea = Es \pm \delta E$

Where;

Ea = Actual value

Es = Specified or rated value

δE = Limiting error

$Ea = 100 \pm 5$

Ea = 105 to 95 mV