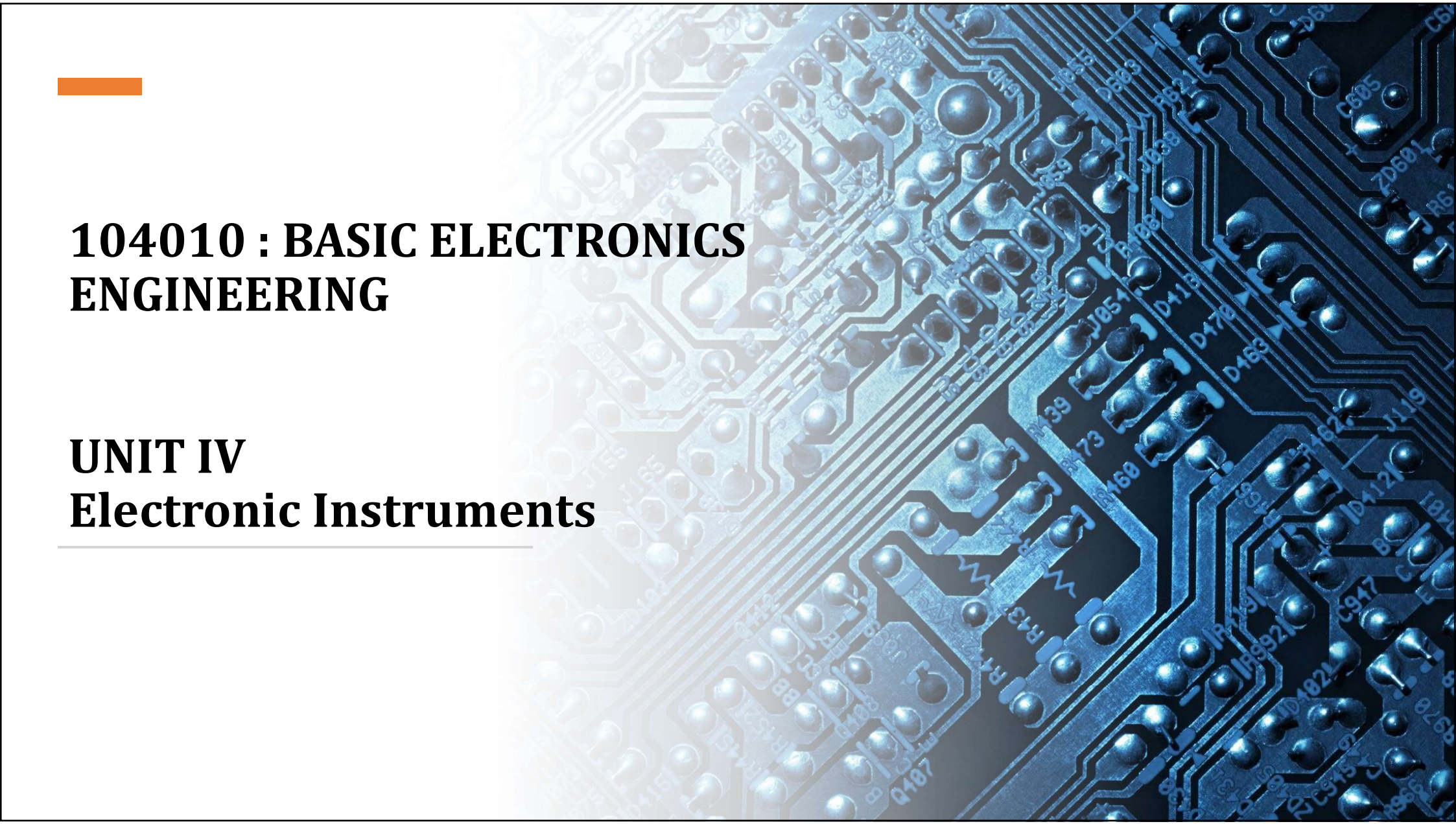
104010 : BASIC ELECTRONICS ENGINEERING

UNIT IV
Electronic Instruments



Outline

- Basics of measurements
- Principles and block diagram of Digital Multimeter
- Function Generator
- Digital Storage Oscilloscope (DSO)
- Power scope
- AC/DC power supply
- Auto transformer
- Analog ammeter and voltmeter.

Definitions

- Instrument: A device or mechanism used to determine the present value of the quantity under measurement.
- Measurement: The process of determining the amount, degree, or capacity by comparison (direct or indirect) with the accepted standards of the system units being used.
- Accuracy: The degree of exactness (closeness) of a measurement compared to the expected (desired) value.

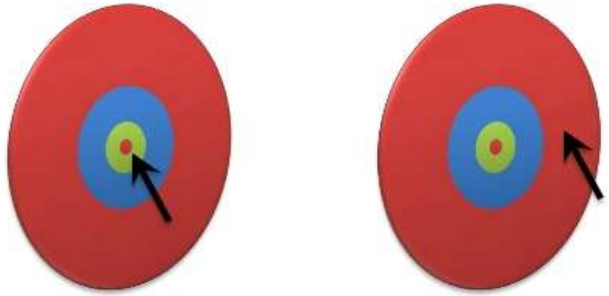
Accuracy

- A measure of how close a measurement is to the true value of the quantity being measured.
- Example: A voltmeter with 1% accuracy indicates a value as 200 V.

  Possible error = ± 1% of 200 V

  = ± 2 V

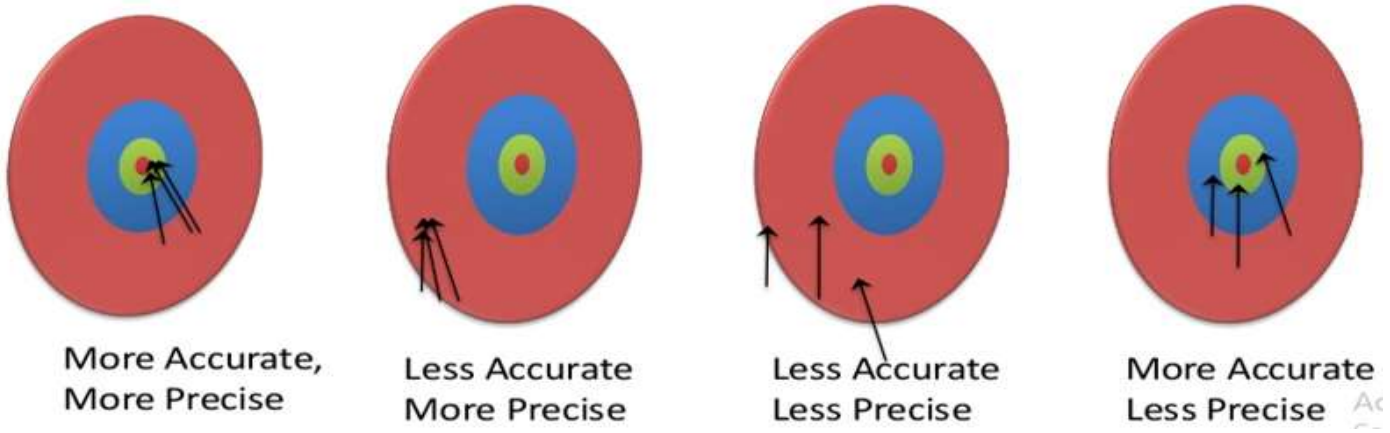
Thus, the true value lies between 198 V to 202V.



More accurate Less accurate

Precision

- The term Precise means clearly and sharply defined.
- Precision is a measure of reproducibility of measurement, i.e., given a fixed value of a quantity, precision is a measure of degree of agreement within a group of measurements.



Resolution

If input is changed from some initial arbitrary value (may be zero), then output will not change until a minimum increment of input is observed.

Thus the smallest increment in input (quantity being measured) that can be detected by the instrument is called **resolution** (discrimination)

Smallest value of input which can be detected by instrument is called **Threshold**.

What is a multimeter?

- A Multimeter is a device used to measure voltage, resistance and current in electronics & electrical equipment.
- It is also used to test continuity between to 2 points to verify if there is any breaks in circuit or line.
- There are two types of multimeter Analog & Digital:
  - Analog has a needle style gauge.
  - Digital has LCD display.

Analog and Digital Multimeter

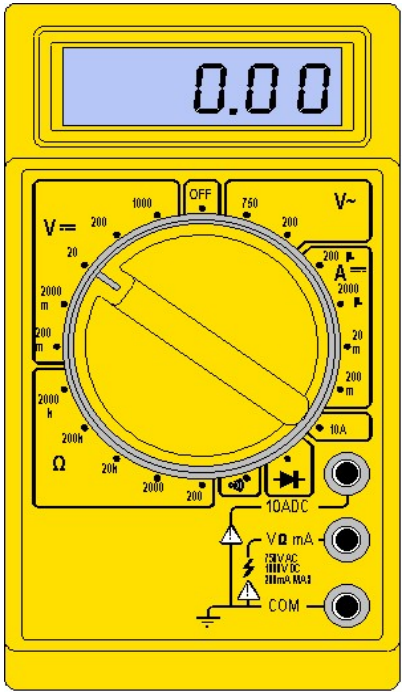
DMM (Digital Multimeter)

- The face of a digital multimeter typically **includes four components:**

  - **Display:** Where measurement readouts can be viewed.
  - **Buttons:** For selecting various functions; the options vary by model.
  - **Dial (or rotary switch):** For selecting primary measurement values (volts, amps, ohms).
  - **Input jacks:** Where test leads are inserted.

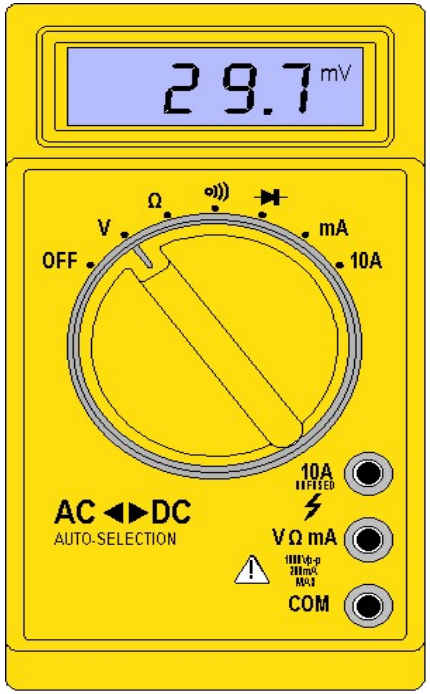
There are 2 styles of Digital multimeters.

Switched
Manually switch between ranges
to get most accurate reading.



Both styles work the same.

Auto Range
Switches between ranges
automatically for best reading.

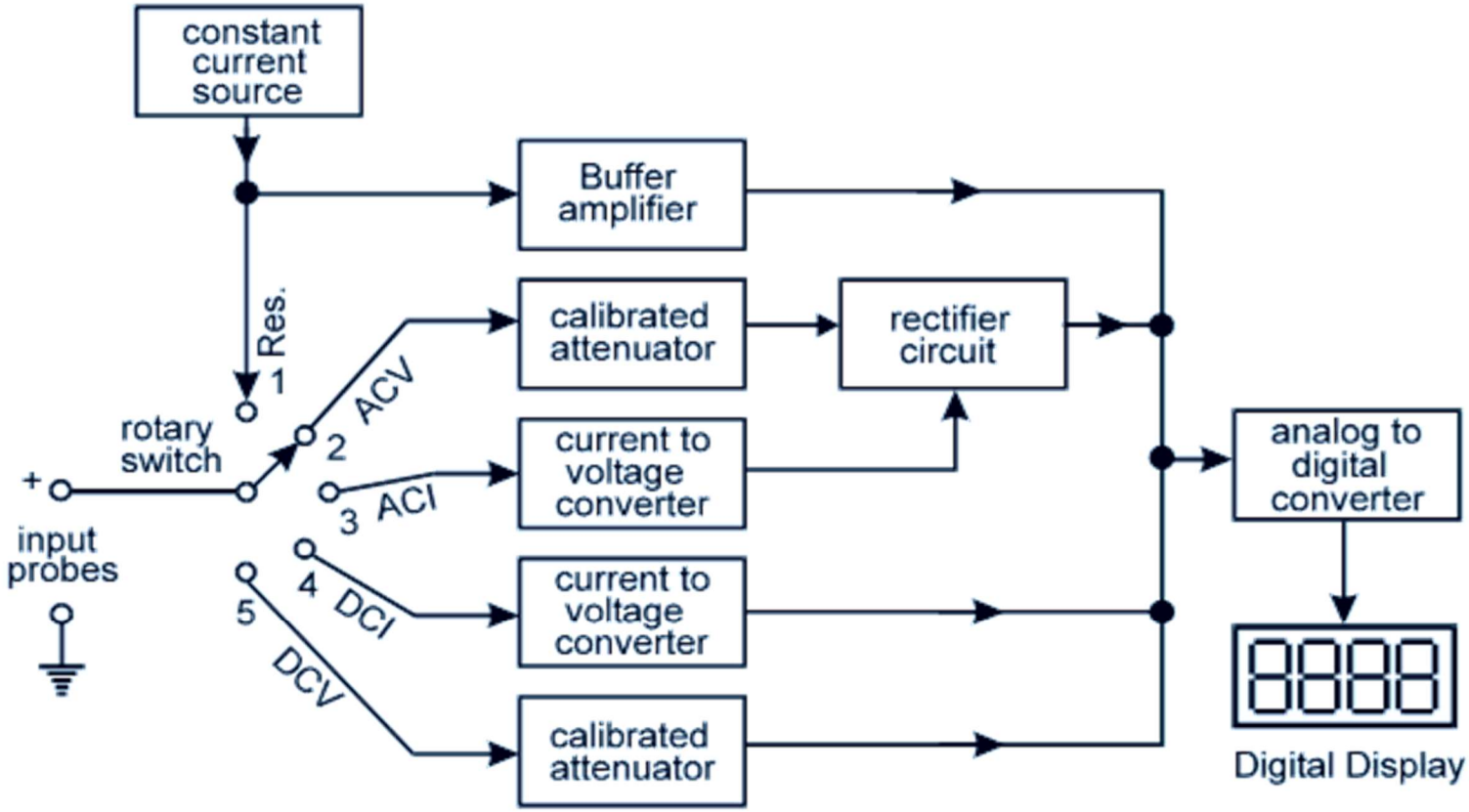


Common DMM Symbols

~	AC Voltage		Ground
⎓	DC Voltage	⊣(	Capacitor
Hz	Hertz	µF	MicroFarad
+	Positive	µ	Micro
—	Negative	m	Milli
Ω	Ohms	M	Mega
→|	Diode	K	Kilo
•)))	Audible Continuity	OL	Overload

- These symbols are often found on multimeter and schematics.
- They are designed to symbolize components and reference values.

Basic Block Diagram



Resistance Measurement

- In the first position of the switch the input goes to ohms select. In this mode the input to the multimeter is an unknown resistance.
- As the unknown resistance must form a part of the potential divider with the internal constant current source and range multiplier resistor, it is shown to be connected to the buffer amplifier.
- At the same time, the block constant current generator is linked with the input terminal. Therefore, the buffer amplifier will amplify only the voltage that is developed across the unknown resistance.
- The unknown resistance and the internal range resistor form a potential divider using the current from the constant current source. Hence the resistance to voltage conversion is complete and the D.V.M. reads the resistance.

AC Voltage Measurement

- The second position of the range switch is marked as Volts (A.C.).
- The input signal as an unknown alternating voltage will go to the calibrated attenuator.
- The output of the attenuator will go to the precision AC to DC converter. The output of the AC/DC convener will go, to the DVM module. Selecting the proper range, we can measure alternating voltage.

AC Current Measurement

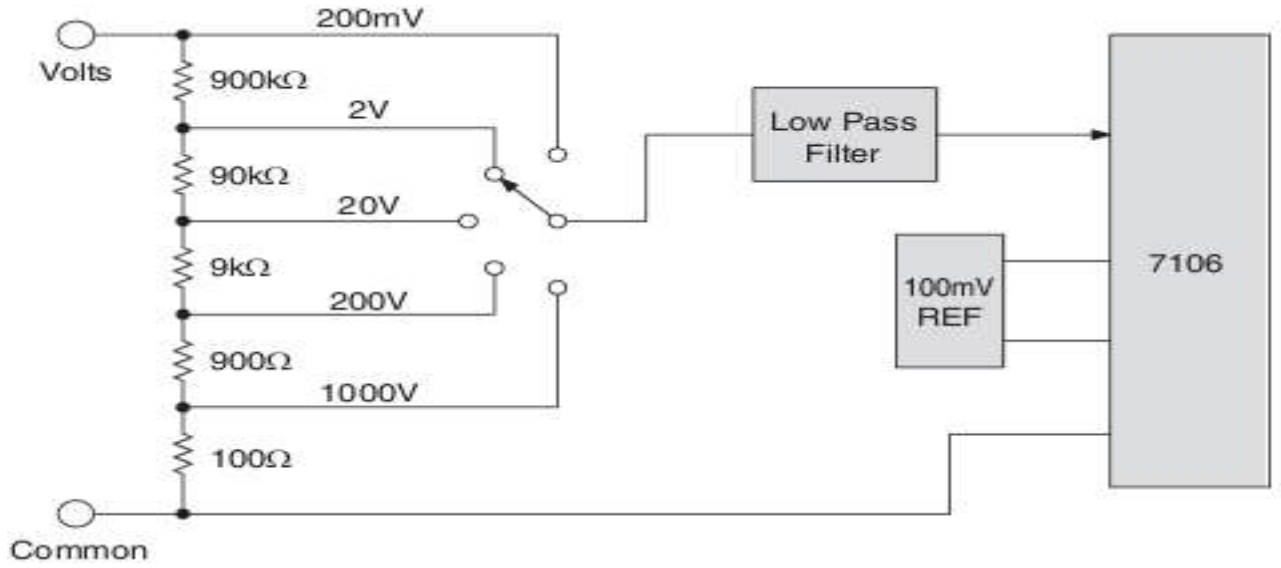
- The third position of the switch is marked as current (A.C.). Hence the unknown current is to be measured.
- The internal shunt carries unknown current, and the voltage developed across it will be converted into steady voltage D.C.(voltage), by the AC/DC converter.
- As the converter's output is given to the D.V.M, module the current is displayed. Different shunts will be selected by a range selector used with the shunt circuit.

DC Current Measurement

- In the fourth position the direct current can be measured. The unknown current flows through the selected shunt (range selector is used).
- The voltage developed across this shunt goes to D.V.M. module. So in the fourth position of the mode selector, we will be able to measure direct current.

DC Voltage Measurement

- The fifth position is marked as volts D.C. The input is the unknown voltage. This voltage passes through a calibrated attenuator.



Why Digital Multimeters (DMM or DVOM)

- Modern multimeters are often digital due to their accuracy, durability and extra features. In a digital multimeter the signal under test is converted to a voltage and an amplifier with electronically controlled gain preconditions the signal.
- A digital multimeter displays the quantity measured as a number, which eliminates parallax errors.
- Modern digital multimeters may have an embedded computer, which provides a wealth of convenience features. Measurement enhancements available include:
    - Auto-ranging,
    - Auto-polarity for direct-current readings, shows if the applied voltage is positive (agrees with meter lead labels) or negative (opposite polarity to meter leads).
    - Sample and hold, which will latch the most recent reading for examination after the instrument is removed from the circuit under test.

Advantages of Digital Multi-meter:

- It offers automatic output display.
- It ensures accuracy.
- It has auto polarity functions.

Disadvantages of Digital Multi-meter:

- It does not do well with measurement fluctuations.
- It is more expensive than the analog type.
- It can be difficult to find one for your specific needs.

Questions

1. Explain what is the difference between an ammeter and a voltmeter?

Ammeter is a low resistance instrument while the voltmeter is a high resistance one.

2. Explain why an ammeter should be of very low resistance?

Ammeter, which is connected in series with the circuit carrying the current under measurement, must be of very low resistance so that the voltage drop across the ammeter and power absorbed from the circuit are as low as possible.

3. Explain why a voltmeter should be of very high resistance?

Voltmeter, which is connected in parallel with the circuit across which the voltage is to be measured, must be of very high resistance so that the current flowing through the voltmeter and the power absorbed from the circuit are minimum possible.

4. How an ammeter can be changed to a voltmeter?

An ammeter or low range can be converted into a voltmeter by connecting a high resistance in series with it provided the current through the series combination is within the range of the ammeter when connected across the voltage under measurement.

5. Explain what happens when an ammeter is connected across the circuit?

If an ammeter is connected in parallel to the circuit like a voltmeter, a very high current will flow through it which will produce such an excessive heat the insulation of the wire carrying the current will be destroyed. The wire may itself melt away. Thus, the instrument will get damaged.

6. Explain what happens when a voltmeter is connected in series with the circuit?

If a voltmeter is connected in series with the circuit, the circuit resistance will become too large and consequently a very small current will flow through it. The instrument will, however, read almost the same emf acting on the circuit.

7. Explain what do you understand by ammeter shunt?

An ammeter shunt is merely a low resistance that is placed across the coil circuit of the instrument in order to measure fairly large currents.

8. Explain what do you understand by voltmeter multiplier?

Voltmeter multiplier is a high non-inductive resistance connected in series with the voltmeter coil and is used for increasing the range of a voltmeter.

9. Explain what is VOM?

The volt-ohm-milliammeter (VOM) is another name of multimeter.

References:

- “Electronic Instrumentation” by H.S. Kalsi, 3rd Edition, Tata McGraw Hill.
- “Electronic Instrumentation and Measurement” by William D. Cooper, Albert D. Helfrick , Prentice Hall PTR.
- Web Resources

Thank you!