**Paper: PHY-SEC-4014**

**Basic Instrumentation Skills**

## Unit- VII: DIGITAL INSTRUMENTS

### Digital Meters

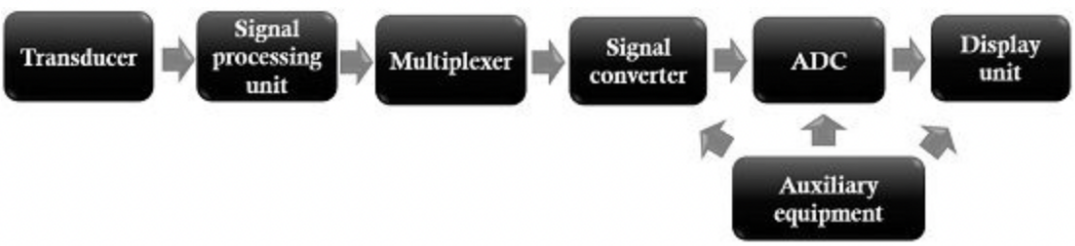
A digital meter has a display consisting of four (in some cases more) digits, together with polarity symbols (+ and -) and a decimal point that automatically appears between the correct pair of digits. The display also shows the units of measurement, such as 'V', 'mV' or 'Ω'. The display is a liquid crystal display and is updated at intervals of a few seconds. The input terminals of a digital meter connect the test circuit to an operational amplifier with FET inputs. The result of this is that the digital meter draws virtually no current from the test circuit.

Digital meters are the product of the latest developments in electronic technology so it is to be expected that they will incorporate many features that are not available on the typical moving-coil meter. As well as a wide selection of voltage, current and resistance ranges (including accurate low-resistance range) many of these meters also provide for measurements of capacitance and frequency. A continuity tester, which produces a 'beep' when there is an electrical connection between the probes is almost a standard feature. The meter may have a temperature probe (a thermocouple) and display the temperature in degrees Celsius or Fahrenheit. The more expensive digital meters include circuits for testing diodes and transistors, including measurement of transistor gain.

As well as indicating instantaneous readings, the more expensive digital meters have the ability to process a series of readings taken over a given period of time.

At the end of the period, they can display the minimum, the maximum, the difference between the minimum and maximum, and the average of the readings it has taken since it was last reset. The digital multimeter, digital voltmeter, digital frequency meter, etc. are the examples of the digital meters.

The figure below shows the block diagram of a digital meter:



As we can see, it consists of various units, the operation of each is discussed below:

1. **Transducer**: A transducer is a device that changes the physical quantity to be measured into its equivalent electrical form. The applied input can be temperature, pressure, velocity, displacement etc. It basically converts a form of energy into another.
2. **Signal processing unit**: This unit is mainly composed of amplification circuitry along with balancing circuits and calibrating elements. The output of the transducer which is the electrical form of the quantity to be measured is fed to the signal processing unit. This basically amplifies or modifies the output of the transducer to such an extent that it can be easily detected and accepted by the other units of the system.
3. **Multiplexer**: Multiplexer mixes the multiple analog signals supplied by the processing unit. It produces an individual signal by mixing various applied signals. This signal is then processed further.
4. **Signal converter**: This unit takes the output of the multiplexer and generates such a signal that can be processed by further units of the system.
5. **Analog to digital converter**: ADC plays a crucial role in the digital instrumentation system. It converts the applied analog data signal into its equivalent digital form. This converted digital data is then provided to the display unit.
6. **Display unit**: This unit shows the actual quantity that is to be measured in the numerical form. This can be a CRO or a computer monitor etc. depending on the need of the user.
7. **Auxiliary Equipment**: This unit is responsible for the functioning of the overall system. It basically helps to have linear results and performs tasks like a limit comparison to ensure proper working of the system.

## Difference between Analog and Digital Instruments

The following table highlights the major differences between analog and digital instruments −

| Analog Instrument | Digital Instrument |
|---|---|
| The type of instrument which works on electromagnetic effects and produces the output in analog form (wave or deflection of pointer) is called an analog instrument. | The type of instrument which consists of solid state components and shows the results in the digital form (digits on a screen) is known as digital instrument. |
| The construction of an analog instrument is simple and direct reading type, involves the use of magnet (permanent or electromagnet) and a coil. | The construction of digital instrument is little complex than analog instrument, as it uses electronics and converter circuit for analog to digital conversion and vice-versa. |
| Analog instruments show the output by the deflection of a pointer on a dial or scale. | Digital instrument shows the output on a digital display screen as a text or number. |
| Analog instruments can be used in any type of environmental conditions. | Since digital instrument involves electronic devices which requires proper environmental conditions to function. |
| In analog instruments, moving parts are present. | There is no moving parts present in the digital instruments. |
| With the analog instruments, there is a possibility of considerable observational errors like parallax error. | Digital instruments are free from observational errors. |
| Analog instrument uses continuous variation of the signal and records its waveforms. | Digital instruments use sampling techniques for the conversion of input signal into binary signal (or digital signal). |
| Analog instruments do not require extra (or auxiliary) power supply. | An extra source of power is required in the digital instruments. |
| Analog instruments are less accurate. | Digital instruments are more accurate. |

| Analog Instrument | Digital Instrument |
|---|---|
| The sensitivity of analog instruments is more. | Digital instruments are less sensitive. |
| The cost of analog instruments is less. | Digital instruments are costlier than analog instruments. |
| Analog instruments do not use display screen (LCD or LED) to show the output. | Digital instruments use a display screen to show the output. |
| The resolution of analog instruments is less. | Digital instruments have high resolution. |
| The common examples of analog instruments are Permanent magnet moving coil instrument, galvanometer, needle type speedometer of automobile, moving iron instrument, mercury thermometer, etc. | Some examples of digital instruments are digital multimeter, digital ammeter and voltmeter, clamp-meter, etc. |

## Important characteristics of Digital Instruments

The digital devices have following important features.

1. The accuracy of the digital electronic instrument is very much high.
2. The digital instrument consists sensitive elements which are easily reacted with the surrounding temperature and humidity.
3. The input impedance of the digital instrument is very high because of which it can draw very less power.
4. The digital instrument is less portable.
5. The cost of the instrument is high.
6. The instrument is free from the parallax error.
7. In analogue instruments, the pointer is used for indicating the measuring voltage because of which the parallax error occurs. While in digital instruments the output is display on the screen. Thus, the chances of errors are less on it.