Instrumentation and measurement
Second year
MSC. Zainab kadum jabber

Lecture two

Standard of Measurements

A standard of measurement is a physical representation of a unit of measurement.

A unit is realized by reference to an arbitrary material standard or to natural phenomena including physical and atomic constants.

Standard of measurement classified by their function and application in the following

categories:

1. International standards

2. Primary standards

3. Secondary standards

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4. Working standards

The international standards are defined by international agreement. They represent certain units of measurements to the closest possible accuracy that production and measurement technology allow. These standards are maintained at the International Bureau of Weights and Measures in America and not available to the ordinary user of measuring instruments.

The primary (basic) standards are maintained by national standards laboratories in different parts of the world.

The National Bureau of standards (NBS) in America, National Physical Laboratory (NPL) in Britain, and Physikalisch Technische in Germany. The primary standards represent the fundamental units and some of the derived mechanical and electrical units.

Primary standards are not available for use outside the national laboratories. One of the main functions of primary standards is the verification and calibration of secondary standards.

Secondary standards are the basic reference standards used in industrial measurement laboratories.

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These standards are maintained by the particular involved industry and are generally sent to the national standards laboratories (primary) on a periodic basis for calibration and comparison

Working standards are the principal tools of a measurement laboratory.

They are used to check and calibrate general laboratory instrument for accuracy and performance or to perform

comparison measurements in industrial applications. A manufacturer of precision resistances, for example, may use a standard resistor (a working standard) in the quality control department of his

plant to check his testing equipment

Electrical Standards

1. The Absolute Ampere

The international system of units (S.I) defines the ampere (the fundamental unit of

electrical current) as the constant current which, if maintained in two straight parallel conductors

of infinite length and negligible circular cross section placed (1m) apart in a vacuum, will produce between these conductors a force equal to 2x10-7 Newton/meter.

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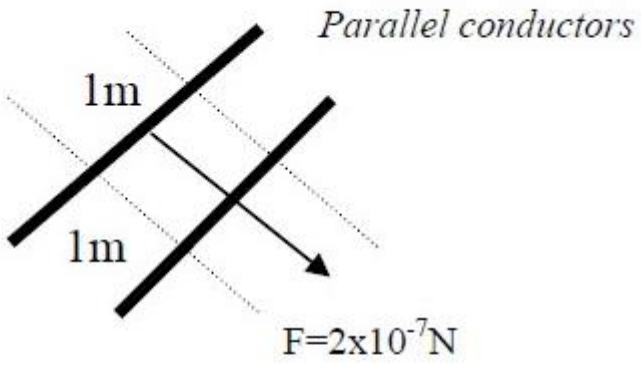

The international Ampere was then defined as that current which deposits silver at the rate of (1.11mg/sec) from a standard silver nitrate solution. The international Ampere was superseded by the absolute Ampere which is determined by Reyleigh current balance. The force acting on the moving coil, and measured by balance is given by:

$$\boxed{F = I^2 \frac{\partial M}{\partial x}}$$ Newton

where I: current in Amp in three series coils.

M: mutual inductance of the coils depends on number of turns, dimensions, and relative positions.

∂x: element of the length a long the axis of the three coils.

If the moving coil is at a distance of half their radius from each of the fixed coil, the ∂M/∂x depend on the ratio of: $\frac{\text{radius of fixed coil}}{\text{radius of moving coil}}$

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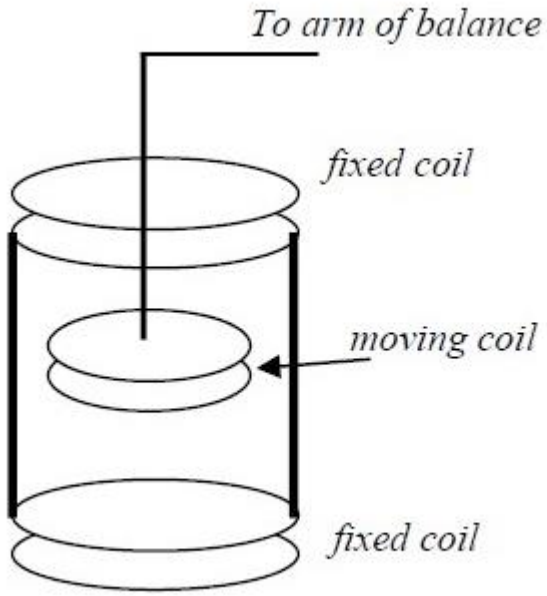

2. Resistance Standards:

The absolute measurement of the ohm is carried out by the international Bureau of weights and Measures and also by the national standards laboratories (NBS) maintains (1Ω standards resistors).

The standard resistor is a coil of wire of some alloy like manganin (alloy of Nickel, manganese, and copper) which has a high electrical resistivity and low temperature coefficient of resistance. The resistance coil is mounted in a double walled sealed container to prevent changes in resistance due to moisture conditions in the

atmosphere. Secondary standards and working standards are available from some instrument manufacturers in a wide range of values usually in multiples of 10Ω.

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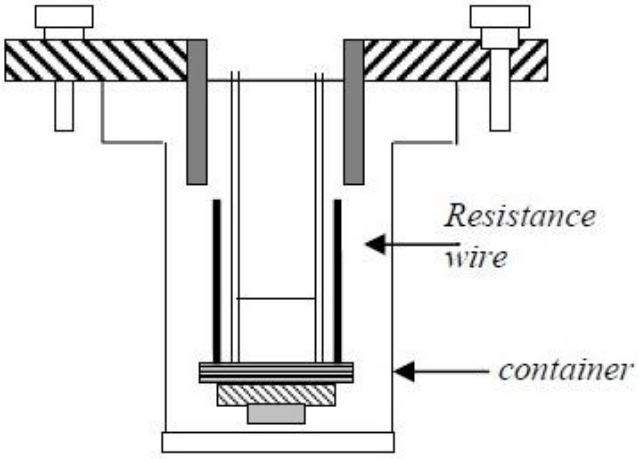

Review on measuring Instrument

1- *Electrical and Electronic Instruments*

The measuring instrument that use mechanical movement of electromagnetic meter to measure voltage, current, power, etc. is called ***electrical*** measuring instrument, so the heart of these instruments was the d'Arsonval meter, while any measurement system use d'Arsonval meter with amplifiers to increase the sensitivity of measurements is called ***electronic*** instrument.

2- *Analogue and Digital Instruments*

An ***analogue*** instrument is the instrument that use analogue signal (signal varying in continuous fashion and take on an infinity number of values in any given range) to display the magnitude of quantity under measurement.

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The ***digital*** instrument uses digital signal (signal which vary in discrete steps and take up only finite different values in a given range, like binary signal which take only two levels zero and one) to indicate the results of measurement in digital form.

3-Absolute and Secondary Instruments

In ***absolute*** instrument the measured value is given in term of instrument constants and the deflection of one part of the instrument e.g. tangent galvanometer, and Rayleigh current balance. In these instruments no calibrated scale is necessary. While in ***secondary*** instruments, the quantity of the measured values is obtain by observing the output indicate by these instruments

Classification of Secondary Instruments

Indicating Instruments

The magnitude of quantity being measured is obtain by deflection the pointer on scale, and the output is indicate either in analogue or digital form like *ammeter, voltmeter, and wattmeter.*

Three forces were acting on the pointer to deflect it in proportional to the quantity being measured, these forces are:

i) *Deflecting Force*

This force gives the pointer the initial force to move it from zero position, it's also called operating force.

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ii) *Controlling Force*

This force control and limits the deflection of the pointer on scale which must be proportional to the measured value, and also ensure that the deflection is always the same for the same values.

iii) *Damping Force*

This force is necessary in order to bring the movement system (pointer) to rise quickly to the measured value, and then stop without any oscillation.

b) *Recording Instruments*

An instrument which makes a written record in any recorded medium to the quantity being measured in order to save information and use it in another time or another place.

Recording instrument may record transient signal, or phenomena which cannot obtain readily. This instruments like *recording devices, X-Y plotter, and oscilloscope.*

c) *Controlling Instruments*

These instruments give an information or instruction (orders) to control on original

measured quantity or control on other devices, like *a computer*.

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