Fundamentals of Electrical Engineering (FCEE0106)

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Chapter 1

Basics Of Measurements

We can define the following for measurements,

1.1 Accuracy

It is the degree of closeness with which the instrument reading approaches the true value of the quantity to be measured. It can be expressed as,

1.1.1 Percentage of Full Scale Reading

In case of instruments having uniform scale, the accuracy can be expressed as percentage of full scale reading.

1.1.2 Percentage of True Value

This is the best method of specifying the accuracy. It is to be specified in terms of the true value of quantity being measured.

1.1.3 Point Accuracy

Such an accuracy is specified at only one particular point of scale.

1.1.4 Percentage of Scale Span

1.2 Tolerance

Tolerance is a term that is closely related to accuracy and defines the maximum error that is to be expected in some value. It is commonly used to describe the maximum deviation of a manufactured component from some specified value.

1.3 Precision

It is the measure of consistency or repeatability of measurements. Precision is a term that describes an instrument's degree of freedom from random errors.

$$\text{Precision} = \frac{\text{measured range}}{\text{standard deviation}}$$

1.4 Reliability

It refers to how consistently a method measures something. If the same method can be consistently used to achieve the same result under the same circumstances, then the measurement is said to be reliable.

1.5 Repeatability

The system design which produces the same high quality product, consistently is said to have high repeatability.

1.6 Resolution

The resolution or discrimination of any instrument is the smallest change in the input signal (quantity under measurement) which can be detected by the instrument.

1.7 Noise

It is any signal that does not convey any useful information.

1.8 Range

It the difference between the maximum and minimum values which can be measured by the instrument.

1.9 Static Sensitivity

The ratio of change in output(ΔA_{out}) of an instrument for a given change in the input(ΔA_{in} that is to be measured is called sensitivity, S.

$$S = \frac{\Delta A_{\text{out}}}{\Delta A_{\text{in}}}$$

$\frac{1}{S}$ is called the deflection factor.

Chapter 2

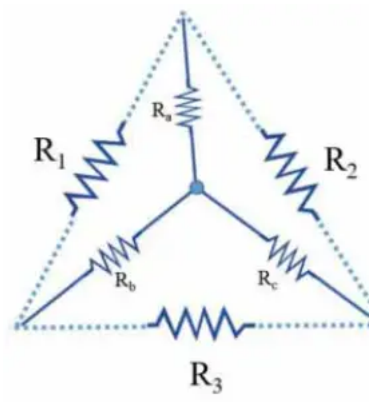
Direct-Current Circuits

2.1 Ohm's Law

Ohm's Law states that the potential difference across any two points of the conductor, will be proportional to the current flowing through it.

$$V \propto I$$
$$\therefore V = RI$$

2.1.1 Star-Delta Transformations



Here, we can convert Star to Delta and vice-versa to make circuit easier to solve,

$$R_1 = R_a + R_b + \frac{R_a R_b}{R_c}$$

$$R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

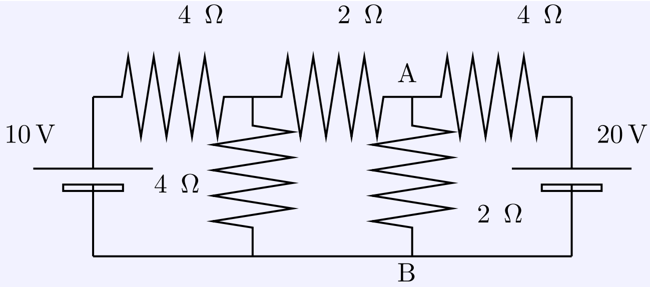
2.2 Kirchhoff's Laws

2.2.1 Kirchhoff's Voltage Law

In any closed circuit ot mesh, the algebraic sum of all the EMFs and voltage drops will be zero.

$$\sum \text{EMF} + \sum IR = 0$$

Example. Calculate the current in branch AB.



Solution. There are three meshes, let the currents be I_1, I_2 and I_3[a].

$$\begin{aligned} 10 - 4I_1 - 4(I_1 - I_2) &= 0 \\ -2I_2 - 2(I_2 - I_3) - 4(I_2 - I_1) &= 0 \\ -20 - 2(I_3 - I_2) - 4I_3 &= 0 \end{aligned}$$

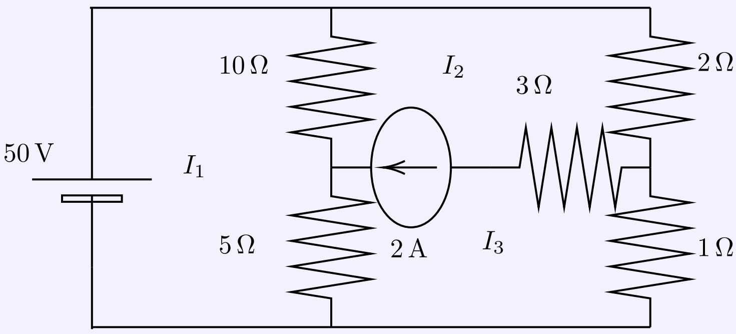
Thus,

$$I_1 = 1.093\,\mathrm{A} \wedge I_2 = -0.312\,\mathrm{A} \wedge I_3 - 3.437\,\mathrm{A}$$

The current in AB is, 3.125 from B to A.

[a] from left mesh to right

Example (Supermesh). Find the current in $5\,\Omega$ resistance.



Solution. The current in each mesh is clockwise.

$$-10(I_1 - I_2) - 5(I_1 - I_3) + 50 = 0$$

The meshes with I_2 and I_3 constitute a supermesh, thus the equation for the supermesh is $I_2 - I_3 = 2$, now, we neglect the $2\,\mathrm{A}$ and $3\,\Omega$ and apply KVL to supermesh,

$$-10(I_2 - I_1) - 2I_2 - I_3 - 5(I_3 - I_2) = 0$$

Thus, we get,

$$I_1 = 20\,\mathrm{A} \wedge I_2 = 17.33\,\mathrm{A} \wedge 15.33\,\mathrm{A}$$

The current in $5\,\Omega$ resistance is $I_1 - I_3 = 4.67\,\mathrm{A}$.

2.2.2 Kirchhoff's Current Law

The algebraic sum of all the currents meeting at a point or a junction will be zero.

$$\sum I = 0$$