Sec (1)

Measurement of errors

القيمه المراد قياسها

In practice, it is impossible to measure the exact Value of the measurand.

There is alaways some difference between the measured Value and the true Value of the unknown quantity (measurand)

$A_m \rightarrow$ measured Value

$A \rightarrow$ true or absolute Value

The difference between measured Value and true Value called absolute error (δA) ε_o

$$\delta A = A_m - A \qquad \delta A = \varepsilon_o$$

The ratio of absolute error to the true Value of the unknown quantity to be measured called relative error ε_r

$$\varepsilon_r = \frac{\delta A}{A} = \frac{\varepsilon_o}{A}$$

when difference between true Value (A) and measured Value (A_m) is Very Small $\therefore A \simeq A_m$

$$\therefore \varepsilon_r = \frac{\delta A}{A_m} = \frac{\varepsilon_o}{A_m}$$

The relative error is generally expressed as Percentage Value

$$\text{Percentage error} = \varepsilon_r * 100 = \frac{\varepsilon_o}{A_m} * 100 = \frac{\varepsilon_o}{A} * 100$$

The measured Value of the unknown quantity may be more than or less than the true Value, So the manufactures have to specify the deviations from the specified Value of aparticular quantity

→ The Limits of these deviations from specified Value are defined as limitting or guarantee errors.

→ The magnitude of ogiven quantity having aspecified magnitude A_m and a maximum error $\pm \delta A$ must have amagnitude between the limits

$$A_m - \delta A \quad \text{and} \quad A_m + \delta A$$

$$\therefore A = A_m \pm \delta A = A_m \pm A_m \varepsilon_r = A_m(1 \pm \varepsilon_r)$$

Sheet (1) Soluations.

$\boxed{1}$ 0-25 A ammeter , $\mathcal{E}r$ of instrument = 1% , $Am = 10A$
determine the limitting error in Percentage

Soluation

$$\mathcal{E}r = \frac{\text{Percentage error}}{100} = \frac{1}{100} = 0.01$$

$$\delta A = \mathcal{E}r * A$$

$$\delta A = 0.01 * 25 = 0.25 A$$

measured Value $Am = 10 A$

$\therefore$ limitting error at this current $= \frac{\delta A}{Am} = \frac{0.25}{10} = 0.025$

Limitting error in Percentage $= 0.025 * 100\% = 2.5\%$ #

$\boxed{2}$ $L = 20H \pm 5\%$, determine the limits of inductance

Soluation

relative error $\mathcal{E}r = \frac{\text{Percentage error}}{100} = \frac{5}{100} = 0.05$

limitting Value of inductance $A = Am \pm \delta A$

$$= Am \pm \mathcal{E}r\, Am$$

$$= Am\,(1 \pm \mathcal{E}r)$$

$$= 20\,(1 \pm 0.05)$$

$$= 20 \pm 1\ H$$ #

[3] 0 - 250V Voltameter , ε_r of instrument = 2%

$A_m = 150V$ determine limitting error in Percentage

Soluation

ε_r of instrument = $2\% = \frac{2}{100} = 0.02$

$\varepsilon_r = \frac{\delta A}{A}$ $\delta A = \varepsilon_r * A = 0.02 * 250 = 5V$

measured Value (A_m) = 150V

$\because$ limitting error of this Voltage $= \frac{\delta A}{A_m} = \frac{5}{150} = 0.0333$

Percentage limitting error $= 0.0333 * 100\% = 3.33\%$ #

[4] $A_m = 10.25\ \Omega$ & $A = 10.22\ \Omega$ determine the absolute error of the instrument.

Soluation

(absolute error) $\delta A = A_m - A = 10.25 - 10.22 = 0.03\ \Omega$ #

[5] $A_m = 205.3\ \mu F$ & $A = 201.4\ \mu F$ determine relative error ε_r

Soluation

$$\varepsilon_r = \frac{\delta A}{A}$$

$$\delta A = A_m - A = 205.3 - 201.4 = 3.9\ \mu F$$

$$\because \varepsilon_r = \frac{3.9 * 10^{-6} F}{201.4 * 10^{-6}} = 0.0194$$

$$\varepsilon_r \% = 0.0194 * 100\% = 1.94\% \ \#$$

[6] $A_m = 25.34$ Watt , $\varepsilon_o = \delta A = -0.11$ watt determine true Value

$\delta A = A_m - A$ $\because A = A_m - \delta A = 25.34 - (-0.11) = 25.45W$ #