ELECTRONICS ENGINEERING DEPARTMENT

Measurement

Hand Notes For Electronics Engineering Department

HAND NOTES

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* SAT. 15/11/08 *

MEASUREMENTS

BASICS :

$A_t = 10A$ (True value)

$A_m = 9.8A$. (Measured value).

Static error $= A_m - A_t$
(δA) $= 9.8 - 10 = (-)0.2A$

Static correction (δC) $= -\delta A$

$= -(-0.2) = 0.2A$.

Correction is to be done for A_m to get A_t.

$2A \pm 1A$ → 50% error } not good

$1000A \pm 10A$ → 1% error } good.

Relative static error $= \frac{A_m - A_t}{A_t}$

Accuracy :

It is a measure of closeness with which an instrument reading approaches the true value of the quantity being measured (Mesurand).

precission :

Reproducability of measurements.

Measurand : quantity under measurement.

Sensitivity :-

It is the ratio of magnitude of o/p signal to the mag. of i/p signal under measurement.

Dead time :-

It is the time required by a measurement system to respond to change in the measurement. dead time depends on damping factor selected for meter. range : 0.6 to 0.8. ($\xi<1$ under damped with ξ_1 0.6 to 0.8)

Dead zone :-

It is the largest change of i/p quantity for which there is no o/p of the instr.

Resolution of Descrimination :-

The smallest increment in i/p which can be detected with certainity by an instr. is known as Resolution.

R_1 =	1000 Ω ± 10Ω	990	1010
R_2 =	500 Ω ± 5Ω	495	505
		(990+495)	(1010+505)
R_1+R_2 =	1500 ± 15	1485	1515
R_1-R_2 =	500 ± 15	485	515
		(990−505)	(1010−495)

* Resultant error in addition & subtraction of quantity can be obtained by adding all individual errors. They should be expressed in absolute values.

$V = 230V \pm 2\%$

$I = 10A \pm 1\%$

$P = 2300 \pm 3\%$ (V·I)

$R = 23 \pm 3\%$ $(\frac{V}{I})$

* Resultant error in product & division of quantities can be obtained by adding all individual errors and they should be expressed in percentage values.

$I = 10\,A \pm 2\%$

$R = 500\,\Omega \pm 3\%$

Then power $P = I^2R$

$= 50000 \pm [2\times2\% + 1\times3\%]$

$= 50000 \pm 7\%$

Resultant error in polynomials can be obtained by the above method.

NOTE:

It is preferrable to measure the quantity instead of calculation. In the calculation of quantity the error will be more.

eg: By meters

$V \Rightarrow 2\%$

$I \Rightarrow 1\%$

$P \Rightarrow 3\%$

$\rightarrow$ P.f $\Rightarrow 2\%$

By calculation,

$P.f = \frac{P}{VI} = 6\%$

Types of Errors :-

(a). Gross Errors :-

This class of errors mainly comes by human mistakes in reading, recording and calculating the measurements.

(b). Systematic Errors :

(1). Instrumental Errors :-

$\rightarrow$ Due to inherent short comings { Errors in instr. }

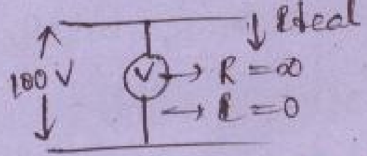
$\rightarrow$ Misuse of instr. $\rightarrow$

1.2 A

0 - 5 A (I) ✓

0 - 100 A (II)

→ Loading effects



but practical
R = finite
I = finite

(2). Environmental Errors :-

Due to temp, electro magnetic effects.

(3). Observational Errors :-

↳ parallox errors

(C). Random Errors :-

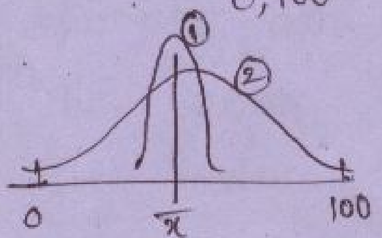
→ these errors occurs due to unknown source or cumulative of different sources together.

→ Random errors can be compensated by statistical Analysis.

↳ Mean $\bar{x} = \dfrac{x_1 + x_2 + \cdots + x_n}{n}$

Eg : 51, 49 → $\bar{x} = 50$

0, 100 → $\bar{x} = 50$ ← not advisable.



$d_1 = x_1 - \bar{x}$

$d_2 = x_2 - \bar{x}$

⋮

$d_n = x_n - \bar{x}$.

Avg. deviation $= \dfrac{|d_1| + |d_2| + \cdots + |d_n|}{n}$.

(σ) Std. deviation $= \sqrt{\dfrac{d_1^2 + d_2^2 + \cdots + d_n^2}{n}}$

(σ^2) Variance $= (S.D)^2$

True value : of the quantity to be measured may be ~~defi~~ defined as an avg. of infinite no. of measured values when the avg. deviation due to various contributing factors tends to be zero.

1.1). $A_m = 6.7\,A$

$A_t = 6.54\,A$

Error $= A_m - A_t$
(δA) $= 0.16\,A$

Correction factor $\delta C = -\delta A$
$= -0.16\,A$.

1.2). Range : $0 - 2.5V$

$A_t = 1.5V$

$A_m = 1.46V$

Error $\delta A = A_m - A_t$
$= -0.04V$

Correction $\delta C = -\delta A$
$= 0.04V$

% Error $= \frac{-0.04}{1.5} \times 100$

$= -2.67\%$

% Error $= \frac{-0.04}{2.5} \times 100$ (w.r.t. full scale).

$= -1.6\%$

1.3). $R = 5000 \pm 10\%$

$= (5000 \pm 500)\,\Omega$

$\rightarrow R = 4500\,\Omega$ to $5500\,\Omega$.

1.4). $(0-10)A \longrightarrow 1.5\%$

Error $= 10 \times \frac{1.5}{100}$

$= 0.15\,A$