MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2025

ELECTRICAL ENGINEERING

CONVENTIONAL Practice Sets

CONTENTS

ELECTRICAL & ELECTRONIC MEASUREMENTS

1 CHAPTER Errors in Measurements

Q.1 Four ammeters M1, M2, M3 and M4 with the following specifications are available:

Instrument	Type	Full scale value (A)	Accuracy % of FS
M1	$3\frac{1}{2}$ digit dual slope	20	±0.10
M2	PMMC	10	±0.20
M3	Electro-dynamic	5	±0.50
M4	Moving-iron	1	±1.00

A current of 1 A is to be measured. Calculate the error in the reading of each instruments and which meter has least error?

Solution:

Error in reading of first meter = FSD × accuracy = $20 \times \frac{\pm 0.1}{100} = \pm 0.02$

Error in reading of second meter = $10 \times \frac{\pm 0.2}{100} = \pm 0.02$

Error in reading of third meter = $5 \times \frac{\pm 0.5}{100} = \pm 0.025$

Error in reading of fourth meter = $1 \times \frac{\pm 1.00}{100} = \pm 0.01$

Fourth meter has least error.

Q.2 The dead zone of a certain pyrometer is 0.125 percent of the span. The calibration is 800°C to 1800°C. What temperature change must occur before it is detected?

Solution:

Given that,

$$\text{Span} = 1800° - 800° = 1000°\text{C}$$

$$\text{Dead zone} = \frac{0.125}{100} \times 1000° = 1.25°\text{C}$$

A change of 1.25°C must occur before it is detected.

Q.3 The limiting errors for a four dial resistance box are:

Units : ±0.2%

Tens : ±0.1%

Hundreds : ±0.05%

Thousands : ±0.02%

If the resistance value is set at 4325 Ω calculate the limiting error for this value.

Solution:

Thousand is set at 4000 Ω and error

$$= \pm 4000 \times \frac{0.02}{100} = \pm 0.8\ \Omega$$

$$\text{For hundred error} = \pm 300 \times \frac{0.05}{100} = \pm 0.15\ \Omega$$

Similarly,
$$\text{For ten error} = \pm 20 \times \frac{0.1}{100} = \pm 0.02\ \Omega$$

and
$$\text{For unit error} = \pm 5 \times \frac{0.2}{100} = \pm 0.01\ \Omega$$

Hence,
$$\text{Total error} = \pm (0.8 + 0.15 + 0.02 + 0.01)\ \Omega$$
$$= \pm 0.98\ \Omega$$

$$\%\ \text{Relative error} = \frac{0.98}{4325} \times 100 = 0.0226\%$$

Q.4 The following measurement are obtained on a single-phase load:

$$V = 200\text{ V} \pm 1\%,\ I = 5\text{ A} \pm 1\% \text{ and } P = 555\text{ W} \pm 2\%$$

If the power factor is calculated using these measurements. What is the calculated power factor in the worst case error?

Solution:

Given that, Voltage, $V = 220 \pm 1\%$,

Current, $I = 5 \pm 1\%$

Power, $P = 555 \pm 2\%$

$$P = VI \cdot \cos(\phi)$$

⇒ Power factor,
$$\text{p.f} = \cos(\phi) = \frac{P}{V.I}$$

$$\text{p.f.} = \cos(\phi) = \frac{555 \pm 2\%}{(220 \pm 1\%)(5 \pm 1\%)} = \frac{555}{220 \times 5} \pm 4\%$$

$$\text{p.f.} = \cos(\phi) = 0.5 \pm 4\%$$

Q.5 An 820 Ω resistance with an accuracy of ±10% carries a current of 10 mA. The current was measured by an analog meter of 25 mA range with an accuracy of ±2% of full scale. Compute the power dissipated in the resistor and determine the accuracy of the result.

Solution:

Resistance, $R = (820 \pm 10\%)\ \Omega$

Current, $I = 10$ mA

Full scale current = 25 mA

Accuracy in current = ±2% of FSD

= ±2% × 25 mA = 0.5 mA

∴ $I = 10\text{ mA} \pm 0.5\text{ mA}$

or $I = (10\text{ mA} \pm 5\%)\text{ mA}$

Power, $P = I^2R$

$$P = (10\text{ mA})^2 \cdot (820) = 0.082\text{ W}$$

Taking log on both sides, $\log P = \log(I^2R)$

Differentiating both sides,
$$\frac{\partial P}{P} = 2\frac{\partial I}{I} + \frac{\partial R}{R}$$

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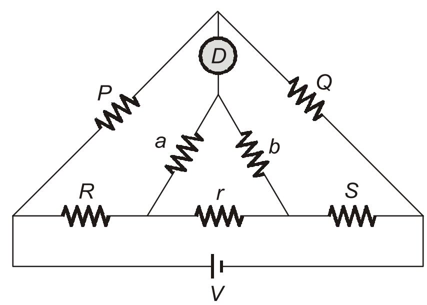
CHAPTER

Measurement of Resistance

Q.1 Draw the circuit of a Kelvin's Double-Bridge used to measure low resistance. Derive the condition for balance. Calculate insulation resistance of a cable in which the voltage falls from 100 to 80 V in 20 s. The capacitance is 300 pF.

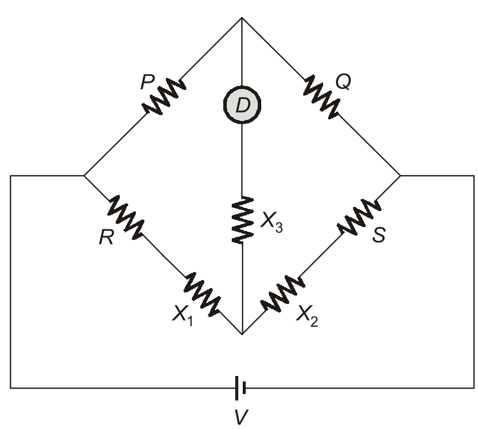
Solution:



Using star-delta conversion:

$$X_1 = \frac{ar}{a+b+r}$$

$$X_2 = \frac{br}{a+b+r}$$



Using,

$$Z_1 Z_4 = Z_2 Z_3$$

$$P\left(S+\frac{br}{a+b+r}\right) = Q\left(R+\frac{ar}{a+b+r}\right)$$

$$\frac{PS}{Q}+\frac{P}{Q}\frac{br}{a+b+r} = \frac{ar}{a+b+r}+R$$

$$\boxed{R=\frac{PS}{Q}+\frac{br}{a(a+b+r)}\left(\frac{P}{Q}-\frac{a}{b}\right)}$$

Condition of balance for Kelvin's double bridge.