MADE EASY PUBLICATIONS

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ELECTRICAL ENGINEERING

Objective Practice Sets

Electrical & Electronic Measurements

1 CHAPTER Introduction

MCQ and NAT Questions

Q.1 The difference between the indicated value and the true value of a quantity is

(a) Gross error (b) Absolute error
(c) Dynamic error (d) Relative error

Q.2 Consider the following statements regarding "precision" of an instrument:

1. Precision is a measure of the degree of agreement within a group of measurements.
2. Precision is necessary, but not sufficient condition for accuracy.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

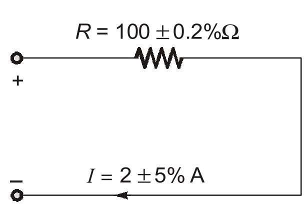
Q.3 A 0 to 200 V voltmeter has a guaranteed accuracy of 1% of full scale reading. The voltage measured by this instrument is 50 V. What is the limiting error?

(a) 4% (b) 2%
(c) 1% (d) 0.25%

Q.4 Two meters X and Y require 40 mA and 50 mA, respectively, to give full-scale deflection, then

(a) sensitivity can not be judged with given information.
(b) both are equally sensitive.
(c) X is more sensitive.
(d) Y is more sensitive.

Q.5 In the circuit given in the figure, the limiting error in the power dissipation 'I^2R' across the resistor R is



(a) 1.2% (b) 5.2%
(c) 10.2% (d) 25.2%

Q.6 Two resistors with nominal resistance values R_1 and R_2 have additive uncertainties ΔR_1 and ΔR_2 respectively. When these resistances are connected in parallel, the standard deviation of the error in the equivalent resistance R is

(a) $\pm\sqrt{\left\{\frac{\partial R}{\partial R_1}\Delta R_1\right\}^2 + \left\{\frac{\partial R}{\partial R_2}\Delta R_2\right\}^2}$

(b) $\pm\sqrt{\left\{\frac{\partial R}{\partial R_2}\Delta R_1\right\}^2 + \left\{\frac{\partial R}{\partial R_1}\Delta R_2\right\}^2}$

(c) $\pm\sqrt{\left\{\frac{\partial R}{\partial R_1}\right\}^2 \Delta R_2 + \left\{\frac{\partial R}{\partial R_2}\right\}^2 \Delta R_1}$

(d) $\pm\sqrt{\left\{\frac{\partial R}{\partial R_1}\right\}^2 \Delta R_1 + \left\{\frac{\partial R}{\partial R_2}\right\}^2 \Delta R_2}$

Q.7 The dead zone in a pyrometer is 0.125% of span. The instrument is calibrated from 500°C to 2000°C. What temperature range must occur before it can be detected in degree centigrade ______.

Q.8 A voltmeter reading 70 V on its 100 V range and an ammeter reading of 80 mA on its 150 mA range are used to determine power dissipation in a resistor. Both these instruments are guaranteed to be accurate within ±2% at full scale deflection. The limiting error (in percentage) in power measurement is ________ .
(Answer upto one decimal place)

Q.9 A first order instrument is characterized by

(a) Time constant only
(b) Static sensitivity and time constant
(c) Static sensitivity and damping coefficient
(d) Static sensitivity and time constant and natural frequency of oscillations

Q.10 A resistance of 108 Ω is specified using significant figures as indicated below:

1. 108 Ω
2. 108.0 Ω
3. 0.00108 MΩ

Among these:
(a) 1 represents greater precision than 2 and 3
(b) 2 represents greater precision but 1 and 3 represents same precision
(c) 2 and 3 represent greater precision than 1
(d) 1, 2 and 3 represent the same precision

Q.11 The total current $I = I_1 + I_2$ in a circuit is measured as I_1 = 150 ± 1 A, I_2 = 250 ± 2 A, where the limits of error are given as standard deviations. I is measured as
(a) (400 ± 3) A
(b) (400 ± 2.24) A
(c) (400 ± 1/5) A
(d) (400 ± 1) A

Q.12 Match **List-I** (Accuracy) with **List-II** (Type of the standard) and select the correct answer:

	List-I		List-II
A.	Least accurate	**1.**	Primary
B.	More accurate	**2.**	Secondary
C.	Much more accurate	**3.**	Working
D.	Highest possible accurate	**4.**	International

Codes:

	A	B	C	D
(a)	3	4	1	2
(b)	1	4	3	2
(c)	3	2	1	4
(d)	1	2	3	4

Q.13 **Assertion (A):** Random errors can be minimized by statistical methods.
Reason (R): These are caused by arithmetic error while taking readings.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.14 The following is not essential for the working of an indicating instrument
(a) deflecting torque
(b) braking torque
(c) damping torque
(d) controlling torques

Q.15 **Assertion (A):** Damping torque is used to bring the pointer to the zero initial position if there is not deflecting torque.
Reason (R): Eddy current damping is preferred for the applications requiring high magnetic field.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.16 Which one of the following is the definition of the dead zone of an instrument?
(a) The time required by an instrument to warm up initially.
(b) The largest change of input quantity for which there is no output of the instrument.
(c) The time required by the instrument to begin to respond to a change in the measurement.
(d) The unmeasured quantity which exceeds the maximum range of the instrument.

Q.17 Five observers have taken a set of independent voltage measurements and recorded as 110.10 V, 110.20 V, 110.15 V, 110.30 V and 110.25 V. Under the situation mentioned above, the range of error is
(a) ±0.3 V
(b) ±0.1 V
(c) ±0.2 V
(d) ±1.0 V

Q.18 During measurement in a college laboratory, nine different set of readings were observed. The standard deviation and variance can be calculated respectively using:
(a) $\sqrt{\frac{\Sigma d^2}{9}}, \frac{\Sigma d^2}{9}$
(b) $\sqrt{\frac{\Sigma d^2}{8}}, \frac{\Sigma d^2}{9}$
(c) $\sqrt{\frac{\Sigma d^2}{8}}, \frac{\Sigma d^2}{8}$
(d) $\sqrt{\frac{\Sigma d^2}{9}}, \frac{\Sigma |d|}{9}$

Q.19 Consider the following:
1. Human errors
2. Improper application of instruments
3. Error due to worn parts of an instrument
4. Errors due to effects of environment

Which of the above come under the type of systematic errors?
(a) 1, 2 and 3
(b) 2, 3 and 4
(c) 2 and 3
(d) 1, 2 and 4

Q.20 Four ammeters M1, M2, M3 and M4 with following specifications are available (Full scale accuracy values as a percent of full scale). M_1 = 20 ± 0.1,

M_2 = 10 ± 0.2, M_3 = 5 ± 0.5 and M_4 = 1 ± 1. A current of 1 A is to be measured to obtain minimum error in the reading which meter should be chosen.

(a) M_1 (b) M_2
(c) M_3 (d) M_4

Q.21 The following measurement are obtained on a single-phase load: V = 220 V ± 2%, I = 10 A ± 1% and P = 500 W ± 2%. If the power factor is calculated using these measurements, the worst case error in the calculated power factor in percentage is _____ (Answer upto 1 decimal place)

Q.22 A utility type voltmeter with an accuracy of ±3% of full scale (at 25°C) is used on 300 V scale to measure 230 V.
(a) What is the possible percentage limiting error?
(b) What range will the actual voltage fall within if the instrument reads 200 V?

(a) 3.9%, 196-204 V (b) 3.9%, 191-209 V
(c) 7.6%, 221-239 V (d) 7.6%, 195-204.5 V

Q.23 Which one of the following is the most stable frequency primary atomic standard for frequency?
(a) Caesium beam standard
(b) Hydrogen maser standard
(c) Rubidium vapour standard
(d) Quartz crystal standard

Q.24 A resistor of 10 kΩ with 5% tolerance is connected in series with a 5 kΩ resistor of 10% tolerance. What is the tolerance limit of the series network?

(a) 5% (b) 6.67%
(c) 10% (d) 8.33%

Q.25 **Assertion (A):** It is always desirable to take measurements as close to the full-scale as possible.
Reason (R): The magnitude of the limiting error is a fixed quantity based on the full-scale reading of the meter and error increases as reading decreases.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.26 The dimensional equation for permeance (P) is expressed as $I^aM^bL^2T^c$. Then value of $a + b - c$ is _______.

Q.27 Two equal resistance, each of 100 Ω ± 1% (standard deviation) are connected in parallel. The standard deviation of the parallel combination will be

(a) 0.5% (b) $\frac{1}{\sqrt{2}}$%
(c) $\sqrt{2}$% (d) 2%

Q.28 Two PMMC ammeters are connected individually in series with armature winding and field winding of a dc shunt motor. Ammeter connected in series with armature and field windings show reading along with % limiting errors I_a = 96.5 A ± 2% and I_f = 4.5 A ± 1% respectively. The value of percentage limiting error in total current will be ± _____ %. (upto 3 decimal places)

Q.29 Consider the following statements:
1. Accuracy is less important than resolution.
2. Linearity is more important than sensitivity.
3. Linearity is less important than sensitivity.
4. Accuracy is more important than resolution.

Which of the above statements are correct?

(a) 1 and 2 (b) 2 and 4
(c) 1 and 3 (d) 3 and 4

Q.30 A power transformer was tested to determine losses and efficiency. The input power was measured as 3650 W and delivered output power was 3385 W with each reading in doubt by ±10 W. The percentage uncertainty in the losses of the transformer is

(a) ± 4.30 % (b) ± 5.34%
(c) ± 2.24% (d) ± 10.24%

Q.31 Four voltmeters M1, M2, M3 and M4 with the following specifications are available:

Voltmeter	Type	Full scale value (V)	Accuracy (% of FSD)
M1	$3\frac{1}{2}$ digit dual slope	100	± 1
M2	PMMC	50	± 2
M3	Electro-dynamic	20	± 2.5
M4	Moving-iron	10	± 2.5

A voltage of 10 V is to be measured. To obtain minimum error in the reading, one should select the meter
(a) M1 (b) M2
(c) M3 (d) M4

Q.32 Match **List-I** (Error parameters) with **List-II** (Values) and select the correct answer : (σ is the standard deviation of Gaussian error) :

	List-I		List-II
A.	Precision index	**1.**	$0.67\,\sigma$
B.	Probable error	**2.**	3σ
C.	Error limit	**3.**	$0.39/\sigma$
D.	Peak probability density of error	**4.**	$0.71/\sigma$

Codes:

	A	B	C	D
(a)	4	2	1	3
(b)	4	1	2	3
(c)	3	1	2	4
(d)	3	2	1	4

Q.33 Certain observations are done using normal or Gaussian curve of errors. It was found that precision index is 3.5. Then the value of standard deviation and probable error are respectively.
(a) 0.202, 0.14 (b) 0.14, 0.202
(c) 4.95, 3.33 (d) 3.33, 4.95

Q.34 Which one of the following statements is not correct?
(a) Correctness is measurement requires both accuracy and precision.
(b) Reproducibility and consistency are expressions that best describe precision in measurements.
(c) It is not possible to have precise measurements which are not accurate.
(d) An instrument with 2% accuracy is better than another with 5% accuracy.

Q.35 Consider the following properties of any measurement system:
1. Fidelity 2. Reproducibility
3. Lag 4. Dead zone

Which of these are both dynamic and undesirable characteristics of a measurement system?
(a) 1 and 3 both (b) 3 only
(c) 3 and 4 both (d) 2, 3 and 4

Q.36 A 4 dial decade box has
Decade a of $10 \times 1000\ \Omega \pm 0.2\%$
Decade b of $10 \times 100\ \Omega \pm 0.1\%$
Decade c of $10 \times 10\ \Omega \pm 0.5\%$
Decade d of $10 \times 1\ \Omega \pm 2\%$
It the setting is at 8172 Ω. Then range of resistance value is
(a) (8165.5 to 8178.5) Ω
(b) (8159.5 to 8184.5) Ω
(c) (8155.5 to 8188.5) Ω
(d) None of these

Multiple Select Questions (MSQ)

Q.37 A set of independent voltage measurements were taken by five observers and were recorded as 15.5 V, 15.8 V, 16 V, 16.5 V, 15 V. Which of the following inferences is/are correct?
(a) The arithmetic mean is 15.76 V.
(b) The average deviation is zero.
(c) The variance obtained is 0.559 V
(d) The variance obtained is 0.313 V^2

Q.38 The total current, $I = I_1 + I_2$ in a circuit is measured as $I_1 = 125 \pm 2$A, $I_2 = 200 \pm 3$A.
(a) If limits of error are given as standard deviations, I is measured as 325 ± 3.61A.
(b) If the errors in I_1 and I_2 are limiting errors, then I is measured as 325 ± 5A.
(c) If limits of error are given as standard deviations, I is measured as 325 ± 2.24A.
(d) If the errors in I_1 and I_2 are considered as limiting errors, then I is measured as $325 \pm \frac{1}{65} A$.

Q.39 The undesirable static characteristics of a measuring system is/are:
(a) Accuracy (b) Sensitivity
(c) Dead zone (d) Hysteresis

■■■■

Answers Introduction

1. (b)	2. (c)	3. (a)	4. (c)	5. (c)	6. (a)	7. (1.875)	8. (6.6)
9. (b)	10. (b)	11. (b)	12. (c)	13. (c)	14. (b)	15. (c)	16. (b)
17. (b)	18. (c)	19. (b)	20. (d)	21. (5)	22. (b)	23. (a)	24. (b)
25. (a)	26. (1)	27. (b)	28. (1.956)	29. (b)	30. (b)	31. (d)	32. (b)
33. (a)	34. (c)	35. (b)	36. (c)	37. (a,d)	38. (a,b)	39. (c,d)	

Explanations Introduction

1. (b)

- Absolute error = Measured/Indicating value – True value
- Relative error = $\frac{\text{Measured value} - \text{True value}}{\text{True value}}$

2. (c)

- Precision is a measure of reproducibility of measurements i.e. for a fixed value of variable, it is the measure of the degree to which successive measurements differ from one another.
- Precision is not sufficient condition for accuracy since precision of an instrument does not guarantee of the accuracy of the instrument.
- Precision is not the guarantee of accuracy.

3. (a)

Given, full scale reading = 200 V

Magnitude of limiting error of instrument is

$$= \frac{1}{100} \times 200 = 2 \text{ V}$$

$$\therefore \text{ Relative limiting error} = \frac{2}{50} \times 100 = 4\%$$

4. (c)

- Sensitivity $\alpha \ \frac{1}{\text{Deflection factor}}$
- Static sensitivity = $\frac{1}{I_{FSD}}$

Here X have lower I_{FSD} and hence X is more sensitive meter.

5. (c)

$$P = I^2 R$$

Limiting error is given as,

$$\frac{dP}{P}\% = 2\frac{dI}{I}\% + \frac{dR}{R}\%$$

$$= 2 \times 5\% + 0.2\% = 10.2\%$$

6. (a)

$$\sigma_{res} = \sqrt{\left(\frac{\partial R}{\partial R_1}\right)^2 \sigma_1^2 + \left(\frac{\partial R}{\partial R_2}\right)^2 \sigma_2^2}$$

$$= \sqrt{\left(\frac{\partial R}{\partial R_1}\right)^2 \Delta R_1^2 + \left(\frac{\partial R}{\partial R_2}\right)^2 \Delta R_2^2}$$

7. Sol.

$$\text{Span} = 2000\,°\text{C} - 500\,°\text{C} = 1500\,°\text{C}$$

$\therefore$ Temperature change

$$= \frac{0.125}{100} \times 1500 = 1.875\,°\text{C}$$

8. Sol.

The magnitude of limiting error of the voltmeter = 0.02 × 100 = 2 V

Percentage limiting error at 70 V

$$= \frac{2}{70} \times 100 = 2.857\%$$

The magnitude of limiting error of the ammeter

$$= 0.02 \times 150 \text{ mA} = 3 \text{ mA}$$

Percentage limiting error at 80 mA

$$= \frac{3}{80} \times 100 = 3.75\%$$

$$P = VI$$

Percentage limiting error in power measurement

$$= 2.857\% + 3.75\% = 6.607\% \approx 6.6\%$$

9. (b)

For first order instruments, transfer function is,

$$\text{T.F.} = \frac{K}{1+sT}$$

where, K = static sensitivity

T = time constant

10. (b)

1. 108 Ω has 3 significant figures.
2. 108.0 Ω has 4 significant figures.
3. 0.000108 MΩ can be written has 108 Ω.

So, it has 3 significant figures.

The more the significant figures, the greater the precision of measurement.

Hence, option (b) is correct.

11. (b)

$$\sigma_I = \sqrt{\left(\frac{\partial I}{\partial I_1}\right)^2 \sigma_{I_1}^2 + \left(\frac{\partial I}{\partial I_2}\right)^2 \sigma_{I_2}^2}$$

$\because$ $I = I_1 + I_2$

Hence, $\dfrac{\partial I}{\partial I_1} = \dfrac{\partial I}{\partial I_2} = 1$

$\therefore$ $\sigma_I = \sqrt{(1)^2(1)^2 + (1)^2(2)^2} = 2.24 \text{ A}$

$\therefore$ $I = (400 \pm 2.24) \text{ A}$

12. (c)

- International standards represents the units of measurements which is closest of highest possible accuracy attainable.
- Order of accuracy:

International standards > Primary standards > Secondary standards > Working standards

13. (c)

Random errors or residual errors are computed using statistical methods. These errors are caused by the happenings or disturbances which we are unaware of. These are not caused by arithmetic error while taking readings. Hence, statement (II) is wrong.

14. (b)

Three types of forces are needed for the satisfactory operation of any indicating instrument. These are:

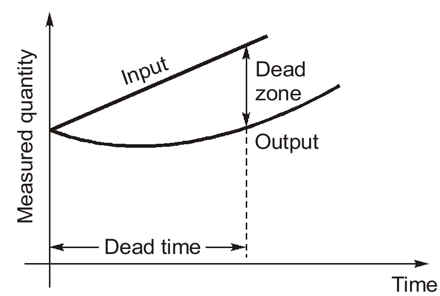
1. Deflecting force
2. Controlling force
3. Damping force

15. (c)

Damping torque is required to damp out the oscillation of pointer. It is the controlling torque (T_c) which bring the pointer to zero position for no deflection. Hence statement (A) is wrong.

16. (b)

In dead zone, there is no change in output, though input changes.



17. (b)

Readings are: 110.10 V
110.20 V
110.15 V
110.30 V
110.25 V

i.e. average reading is 110.20 V.

Range of error

$$= \pm\left|\text{extreme reading} - \text{average reading}\right| = \pm 0.10 \text{ V}$$

Alternate solution:

$$\text{Range of error} = \frac{\text{Max. value} - \text{Min. value}}{2}$$

$$= \pm\frac{110.30 - 110.10}{2}$$

$$= \pm 0.1 \text{ V}$$

18. (c)

For $n = 9$ readings, ($n < 20$)

- Standard deviation $= \sigma = \sqrt{\dfrac{\Sigma d^2}{n-1}} = \sqrt{\dfrac{\Sigma d^2}{8}}$
- Variance $= V = \sigma^2 = \dfrac{\Sigma d^2}{8}$

19. (b)

- Systematic errors are classified as instrument errors, observation errors and environmental errors.

- Errors due to shortcoming in the instrument is instrument error.
- Also, due to effects of external environment, systematic errors occur. Hence, (2), (3) and (4) are correct.

20. (d)

$$LE = \frac{GAE \times FSR}{Reading}$$

where,
LE = Limiting error,
GAE = Guaranteed accuracy error,

$$LE_1 = \frac{0.1 \times 20}{1} = 2\%$$

$$LE_2 = \frac{0.2 \times 10}{1} = 2\%$$

$$LE_3 = \frac{0.5 \times 5}{1} = 2.5\%$$

$$LE_4 = \frac{1 \times 1}{1} = 1\%$$

$\therefore$ Meter M_4 will be used.

21. Sol.

Given,
$$V = 220 \text{ V} \pm 2\%$$
$$I = 10 \text{ A} \pm 1\%$$
$$P = 500 \text{ W} \pm 2\%$$

$\because$ We know, $P = VI\cos\phi$

$$\text{p.f.} = \cos\phi = \frac{P}{VI}$$

$$= \frac{500 \pm 2\%}{(220 \pm 2\%)(10 \pm 1\%)}$$

$$= \frac{500}{220 \times 10} \pm (2\% + 2\% + 1\%)$$

$$= 0.23 \pm 5\%$$

22. (b)

Accuracy = 3% of full scale value

$$\therefore \text{Absolute error} = \frac{3}{100} \times 300 = \pm 9\text{V}$$

$$\text{So limiting error \%} = \frac{9}{230} \times 100 = 3.9\%$$

So, range of reading for 200 V is = 200 ± 9
= 191 – 209 V

23. (a)

A caesium standard or caesium beam standard is a primary frequency standard in which electronic transitions between the two hyperfine grand states of caesium-133 atoms are used to control the output frequency.

24. (b)

Given,
$$R_1 = 10^4 \pm 5\% \; \Omega$$
$$= 10^4 \pm \frac{5}{100} \times 10^4$$
$$= 10^4 \pm 500 \; \Omega$$
$$R_2 = 5000 \pm 10\% \; \Omega$$
$$= 5000 \pm \frac{10}{100} \times 5000$$
$$= 5000 \pm 500 \; \Omega$$

For series connection,
$$R = R_1 + R_2$$
$$= (10^4 + 5000) \pm 1000 \; \Omega$$
$$= 15000 \pm 1000 \; \Omega$$

$$\text{\% tolerance limit} = \frac{1000}{15000} \times 100 = 6.67\%$$

25. (a)

While selecting instruments, particular case should be taken as regards the range. The values to be measured should not lie in the lower third of the range. This is particularly important if the meter accuracy is specified in terms of the full scale deflection. Hence, option (a) is correct.

26. Sol.

$$\because \quad \text{emf} = \frac{\text{Work done}}{\text{Charge}}$$

$$[E] = \frac{[ML^2T^{-2}]}{[IT]} = [I^{-1}ML^2T^{-3}]$$

$$\because \quad \text{emf} = N \cdot \frac{d\phi}{dt}$$

Flux,
$$[\phi] = [\text{emf}][\text{time}]$$
$$= [I^{-1}ML^2T^{-3}][T]$$
$$= [I^{-1}ML^2T^{-2}]$$

$$\because \text{ Flux,} \quad \phi = \frac{\text{mmf}}{\text{reluctance}}$$

$$\because \quad \frac{1}{\text{Reluctance}} = \text{Permeance} = \frac{\phi(\text{flux})}{\text{mmf}}$$

$$[P] = \frac{[\phi]}{[I]}$$

Hence, $[P] = I^{-2} M^1 L^2 T^{-2}$

On comparing,

$$a = -2,\ b = 1,\ c = -2$$

Thus, $a + b - c = 1$

27. (b)

$$R_1 = 100\ \Omega \pm 1\%$$

Standard deviation,

$$\sigma = \sqrt{\left(\frac{\partial R}{\partial R_1}\right)^2 \sigma_{R_1}^2 + \left(\frac{\partial R}{\partial R_2}\right)^2 \sigma_{R_2}^2}$$

Resistances are in parallel,

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{100 \times 100}{100 + 100} = 50\ \Omega$$

$$\frac{\partial R}{\partial R_1} = \frac{R_2^2}{(R_1 + R_2)^2} = \frac{1}{4}$$

$$\frac{\partial R}{\partial R_2} = \frac{1}{4}$$

$$\sigma_{R_1} = 1, \qquad \sigma_{R_2} = 1$$

$$\sigma = \sqrt{\left(\frac{1}{4}\right)^2 (1)^2 + \left(\frac{1}{4}\right)^2 (1)^2} = \frac{1}{2\sqrt{2}}$$

In percentage terms,

$$\sigma = \left(\frac{1/2\sqrt{2}}{50}\right) \times 100 = \frac{1}{\sqrt{2}}\%$$

28. Sol.

Limiting error in total,

$$\frac{\delta x}{X} = \left[\frac{x_1}{X}\frac{\delta x_1}{x_1} + \frac{x_2}{X}\frac{\delta x_2}{x_2}\right]$$

Where,

Armature winding current,

$$x_1 = 96.5\text{ A}$$

and $\frac{\delta x_1}{x_1} = \pm 2\%$ (or) ± 0.02

Fielding winding current,

$$x_2 = 4.5\text{ A}$$

and $\frac{\delta x_2}{x_2} = \pm 1\%$ (or) ± 0.01

Total current drawn,

$$X = x_1 + x_2 = 101\text{ A}$$

$$\frac{\delta x}{X}\% = \pm\left[\frac{96.5}{101} \times 2\% + \frac{4.5}{101} \times 1\%\right]$$

$$= [1.911 + 0.045] = 1.956\%$$

29. (b)

- Linearity is more important than the sensitivity.
- Accuracy is more important than resolution.

30. (b)

Given, $P_1 = 3650$ W, $P_0 = 3385$ W

Uncertainties, $W_{pi} = \pm 10$ W, $W_{po} = \pm 10$ W

Losses in transformer,

$$P_L = P_i - P_0$$

$$= 3650 - 3385 = 265\text{ W}$$

$$\therefore \quad \frac{\partial P_L}{\partial P_i} = 1, \quad \frac{\partial P_L}{\partial P_0} = -1$$

∴ Uncertainty in losses

$$= \pm\sqrt{\left(\frac{\partial P_L}{\partial P_i}\right)^2 W_{pi}^2 + \left(\frac{\partial P_L}{\partial P_0}\right) W_{po}^2}$$

$$= \pm\sqrt{(1)^2(10)^2 + (-1)^2(10)^2}$$

$$= \pm 10\sqrt{2}\text{ W}$$

∴% uncertainty in losses

$$= \frac{\pm 10\sqrt{2}}{265} \times 100 = \pm 5.34\%$$

31. (d)

Error in reading of first meter,

$$\delta M1 = \text{FSD} \times \text{accuracy}$$

$$= 100 \times \left[\pm \frac{1}{100}\right] = \pm 1\text{ V}$$

Error in reading of second meter,

$$\delta M2 = 50\left[\pm \frac{2}{100}\right] = \pm 1\text{ V}$$

Error in reading of third meter,

$$\delta M3 = 20\left[\pm \frac{2.5}{100}\right] = \pm 0.5\text{ V}$$

Error in reading of fourth meter,

$$\delta M4 = 10\left[\pm \frac{2.5}{100}\right] = \pm 0.25\text{ V}$$

Hence, meter M4 has minimum error in the reading.