MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2027

ELECTRICAL ENGINEERING

OBJECTIVE PRACTICE SETS VOLUME - I

CONTENTS

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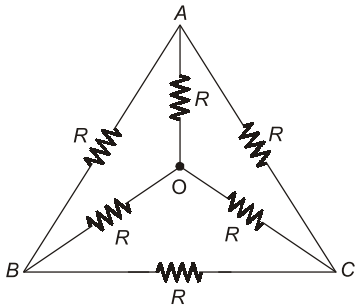
ELECTRIC CIRCUITS

OBJECTIVE PRACTICE SETS

1 CHAPTER
Circuit Element and Energy Sources

MCQ and NAT Questions

Q.1 The effective resistance between the terminals A and B in the circuit shown in the figure is



(a) R (b) $R - 1$

(c) $\frac{R}{2}$ (d) $\frac{6}{11}R$

Q.2 The equivalent star impedance of a balanced delta connected load of value $6 + j9\ \Omega$ is given by

(a) $9 + j6\ \Omega$ (b) $2 + j3\ \Omega$

(c) $18 + j27\ \Omega$ (d) $6 - j9\ \Omega$

Q.3 A network contains only independent current sources and resistors. If the values of all resistors are doubled, the values of the node voltages

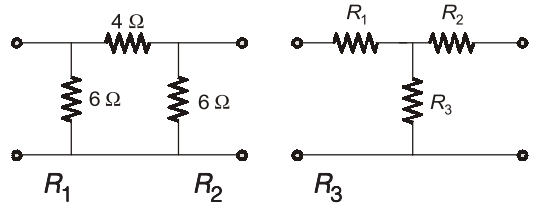
(a) will become half

(b) will remain unchanged

(c) will become double

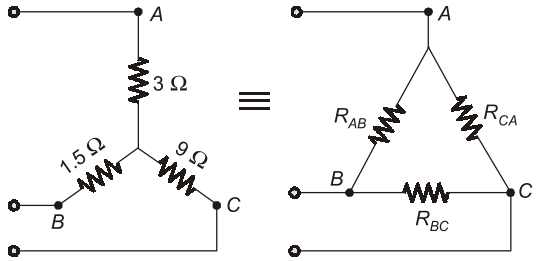
(d) cannot be determined unless the circuit configuration and the values of the resistors are known

Q.4 The value of R_1, R_2 and R_3 of the equivalent 'T' network for the given π network will be such that



	R_1	R_2	R_3
(a)	2.25 Ω	1.5 Ω	1.5 Ω
(b)	1.5 Ω	1.5 Ω	2.25 Ω
(c)	2.25 Ω	1.5 Ω	2.25 Ω
(d)	1.5 Ω	2.25 Ω	1.5 Ω

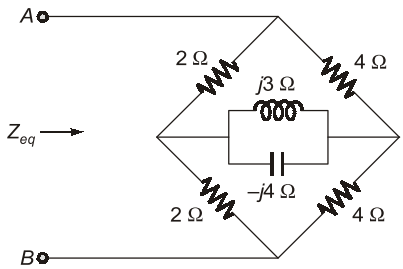
Q.5 For the equivalent figure circuit shown in the given figure, the values of R_{AB} and R_{BC} are respectively



(a) 5 Ω and 15 Ω (b) 15 Ω and 30 Ω

(c) 30 Ω and 5 Ω (d) 20 Ω and 35 Ω

Q.6 In the circuit of figure. The equivalent impedance seen across terminals A, B is _____ Ω.

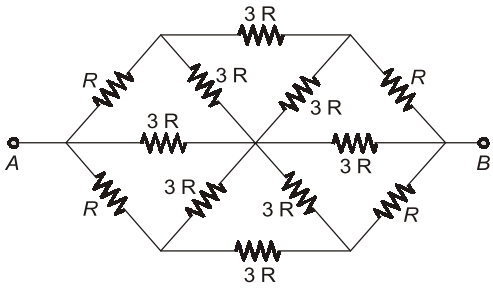


Q.7 If each branch of a delta circuit has impedance $Z/\sqrt{3}$ then, each branch of the equivalent Y circuit has impedance.

(a) $\frac{Z}{\sqrt{3}}$ (b) $\frac{Z}{3\sqrt{3}}$

(c) $3\sqrt{3}Z$ (d) $Z/3$

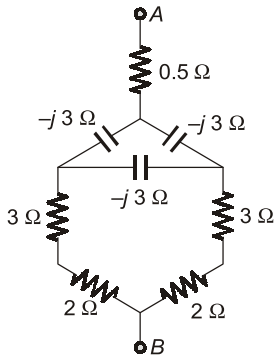
Q.8 The equivalent resistance between terminals A and B for the circuit shown is:



(a) R (b) $\frac{R}{3}$

(c) $\frac{3R}{2}$ (d) $2R$

Q.9 For the circuit shown, the impedance between terminals A and B is:



(a) $9 - j3\ \Omega$ (b) $3 - j1.5\ \Omega$

(c) $j1.5\ \Omega$ (d) $0\ \Omega$

Q.10 A lamp rated at 10 watts, 50 volts is proposed to be used in 110 volts, system. The wattage and resistance of the resistor to be connected in series with the lamp should be

(a) 15 watt, 350 ohms

(b) 10 watts, 250 ohms

(c) 12 watts, 300 ohms

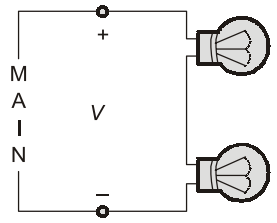
(d) 15 watts, 250 ohms

Q.11 The equivalent resistance of four resistors joined in parallel is 20 ohms. The currents flowing through them are 0.6, 0.3, 0.2 and 0.1 amp. The lowest value resistor is of

(a) 240 ohms (b) 120 ohms

(c) 80 ohms (d) 40 ohms

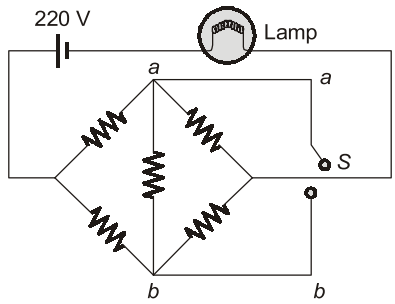
Q.12 The incandescent bulbs rated respectively as P_1 and P_2 for operation at a specified mains voltage are connected in series across the mains as shown in the below figure. Then the total power supplied by the mains to the two bulbs are



(a) $\frac{P_1 P_2}{P_1 + P_2}$ (b) $\sqrt{P_1^2 + P_2^2}$

(c) $(P_1 + P_2)$ (d) $\sqrt{P_1 \times P_2}$

Q.13 All resistances in the circuit in figure are of R ohms each. The switch is initially open. What happens to the lamp's intensity when the switch is closed?



(a) increases

(b) decreases

(c) remains the same

(d) answer depends on the value of R

Q.14 A practical current source is usually represented by

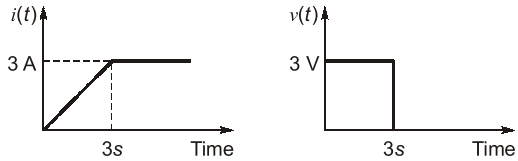
(a) a resistance in series with an ideal current source.

(b) a resistance in parallel with an ideal current source.

(c) a resistance in parallel with an ideal voltage source.

(d) none of these

Q.15 The voltage and current waveforms for an element are shown in figure. The value of circuit element is _____.



(a) 3 H (b) 2 F

(c) 5 H (d) 3 F

Q.16 n resistors each of resistance R when connected in series offer an equivalent resistance of 50 Ω and when reconnected in parallel the effective resistance is 2 Ω. The value of R is

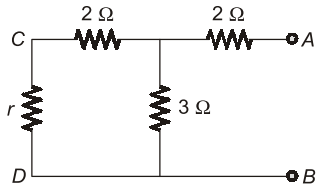
(a) 2.5 Ω (b) 5 Ω

(c) 7.5 Ω (d) 10 Ω

Q.17 Three 30 Ω resistors are connected in parallel across an ideal 40 V source. What would be the equivalent resistance seen by the load connected across this circuit?

(a) 0 Ω (b) 10 Ω
(c) 20 Ω (d) 30 Ω

Q.18 For the circuit shown below the value of r connected between C and D is such that the equivalent resistance of the circuit by looking into circuit through terminals A and B is r only. Then the value of r is



(a) 2 Ω (b) 4 Ω
(c) 3 Ω (d) 6 Ω

Q.19 For a series and a parallel circuit, the equivalent total value of certain parameter X is given by

$$X_e = X_1 + X_2 + X_3 + X_4 + \cdots + X_n$$

where X_i is the i^{th} value of the parameter and X_e is the equivalent value, and n is the number of elements.

The parameter X can be

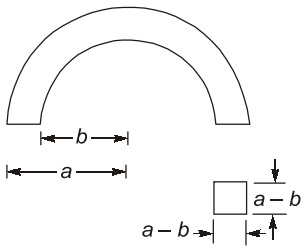
(a) resistance (b) current
(c) voltage (d) power

Q.20 **Assertion (A):** Two wires of same length with different cross-sectional areas are connected in series. The heat produced by the current is more the thicker wire.

Reason (R): The thicker wire has low resistance.

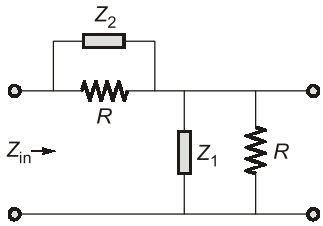
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not a correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Q.21 The resistance measured between the two ends of the toroid shown in the below figure is R. What would be the resistance if both a and b are doubled?



(a) $2R$ (b) R
(c) $R/2$ (d) $R/4$

Q.22 What are the suitable values for Z_1 and Z_2 to make the input impedance, Z_{in} of the below network equal to R?



(a) R and R (b) $2R$ and R
(c) $3R$ and $2R$ (d) $4R$ and $4R$

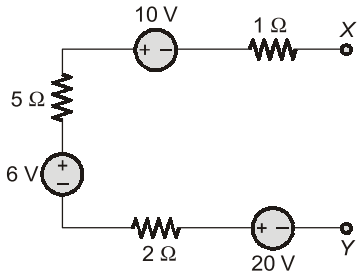
Q.23 **Assertion (A):** Inductors carrying steady direct currents act as effective short circuits with zero voltage across it.

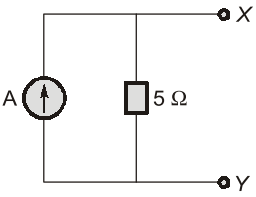
Reason (R): The voltage induced across an inductance is proportional to the rate of change of current di/dt.

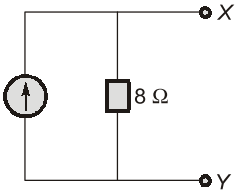
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not a correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Multiple Select Questions (MSQ)

Q.24 The circuit shown below will be represented as



(a)


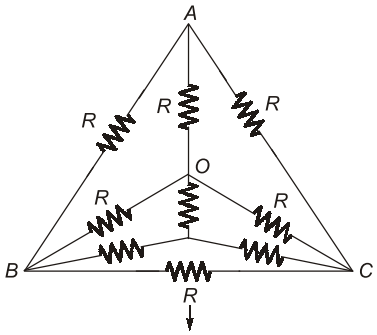
(b)


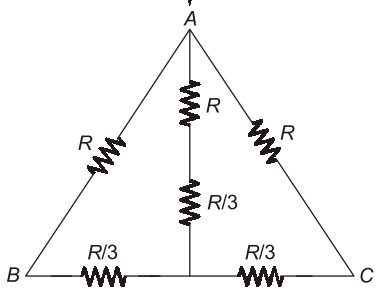
Answers — Circuit Element and Energy Sources

1. (c)	2. (b)	3. (c)	4. (b)	5. (a)	6. (2.67)	7. (b)	8. (c)
9. (b)	10. (c)	11. (d)	12. (a)	13. (c)	14. (b)	15. (a)	16. (d)
17. (a)	18. (b)	19. (d)	20. (d)	21. (c)	22. (a)	23. (a)	24. (b,c)
25. (a,b)	26. (a,b,c,d)	27. (a,b,d)	28. (a,c,d)	29. (a,c,d)			

Explanations — Circuit Element and Energy Sources

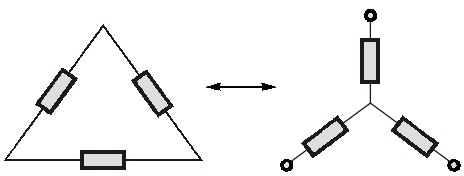
1. (c)





$$R_{AB} = R\left\|\left(\frac{R}{3}+\left(\frac{4R}{3}\middle\|\frac{4R}{3}\right)\right)\right. = \frac{R}{2}$$

2. (b)



$$Z' = \frac{Z\times Z}{3Z} = \frac{Z}{3} = \frac{6+j9}{3} = 2 + j3\ \Omega$$

3. (c)

Since the network contains only independent current sources, so changing resistors in the same proportion the current through each branch will remain same but node voltages will change in the same proportion. Hence, doubling all resistors, node voltages will be doubled.

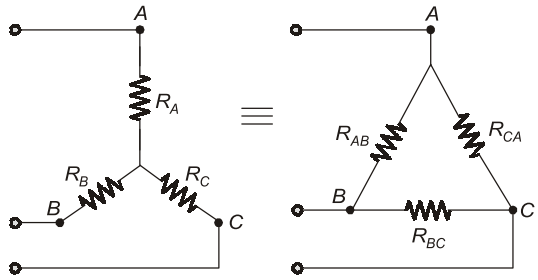
4. (b)

$$R_1 = \frac{4\times 6}{4+6+6} = \frac{24}{16} = 1.5\ \Omega$$

$$R_2 = \frac{6\times 4}{16} = 1.5\ \Omega$$

$$R_3 = \frac{6\times 6}{16} = 2.25\ \Omega$$

5. (a)



$$R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C}$$

$$R_{AB} = 3 + 1.5 + \frac{3\times 1.5}{9}$$

$$= 3 + 1.5 + 0.5 = 5\ \Omega$$

$$R_{BC} = 9 + 1.5 + \frac{9\times 1.5}{3}$$

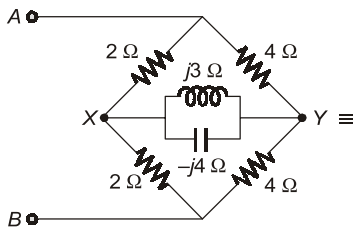
$$= 9 + 1.5 + 4.5 = 15\ \Omega$$

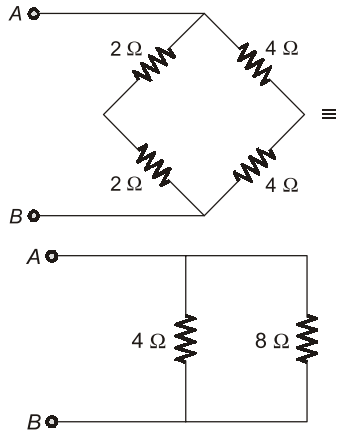
$$R_{CA} = R_A + R_C + \frac{R_A R_C}{R_B}$$

$$= 3 + 9 + \frac{3\times 9}{1.5} = 30\ \Omega$$

6. Sol.

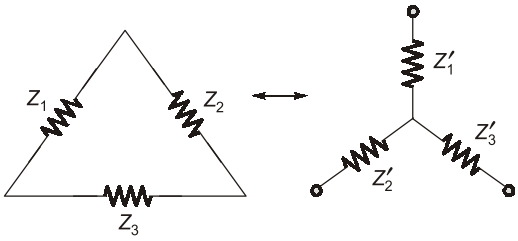
The above circuit is a wheatstone bridge circuit, thus no current will flow through branch XY.





$$Z_{eq} = 8 \,||\, 4 = \frac{8 \times 4}{12} = \frac{8}{3} = 2.67\ \Omega$$

7. (b)



$$Z_1' = \frac{Z_1 Z_2}{Z_1 + Z_2 + Z_3}$$

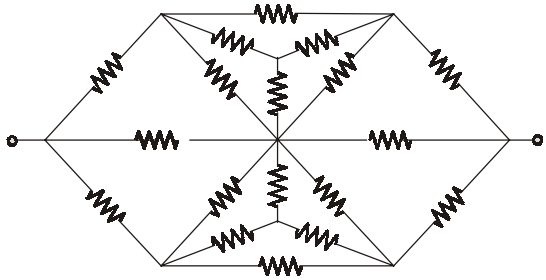
$$Z_2' = \frac{Z_1 Z_3}{Z_1 + Z_2 + Z_3}$$

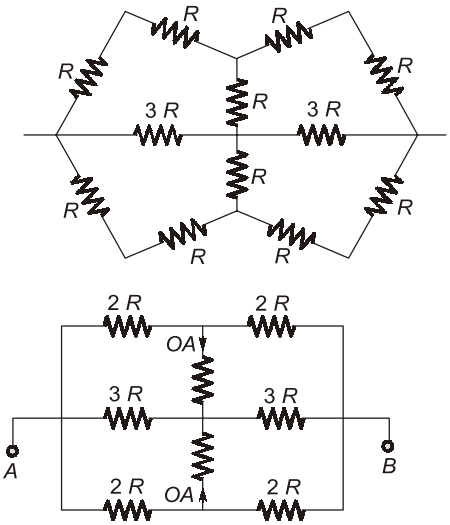
$$Z_3' = \frac{Z_2 Z_3}{Z_1 + Z_2 + Z_3}$$

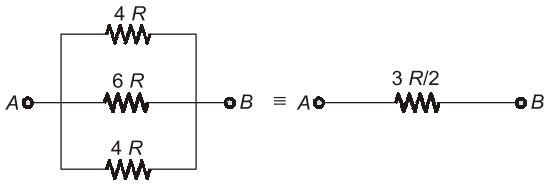
$$Z_1' = \frac{\frac{Z}{\sqrt{3}} \times \frac{Z}{\sqrt{3}}}{\frac{Z}{\sqrt{3}} + \frac{Z}{\sqrt{3}} + \frac{Z}{\sqrt{3}}} = \frac{\frac{Z^2}{(\sqrt{3})^2}}{\frac{3Z}{\sqrt{3}}} = \frac{Z^2\sqrt{3}}{3Z \times 3}$$

$$\Rightarrow \quad Z'_1 = \frac{Z}{3\sqrt{3}}$$

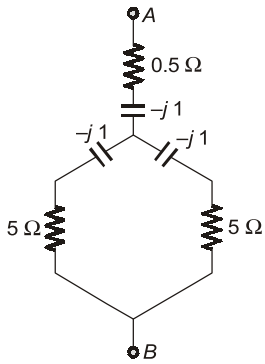
8. (c)







9. (b)

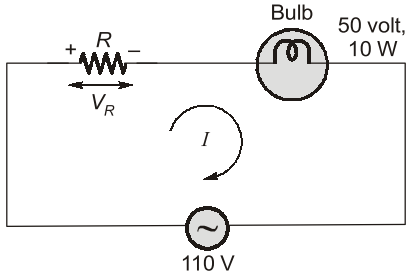


$$[(5 - j) \,||\, (5 - j)] + (0.5 - j)$$

$$[2.5 - j/2] + (0.5 - j)$$

$$(3 - j\,1.5)\ \Omega$$

10. (c)



$V_R = 110 - 50 = 60$ volt

Current in the circuit,

ELECTRICAL AND ELECTRONIC MEASUREMENTS

OBJECTIVE PRACTICE SETS

Page No. 130 - 210

1 CHAPTER

Introduction

MCQ and NAT Questions

Q.1 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

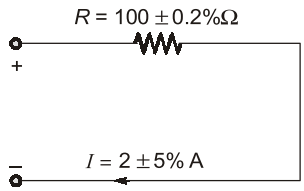
Q.2 A 0 to 200 V voltmeter has a guaranteed accuracy of 1% of full scale reading. The voltage measured by this instrument is 50 V. What is the limiting error?

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

Q.3 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.4 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.5 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.6 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.7 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.8 A resistance of 108 Ω is specified using significant figures as indicated below:

1. 108 Ω
2. 108.0 Ω
3. 0.000108 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.9 **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.10 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.11 **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.12 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.13 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.14 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.15 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.16 The following measurement are obtained on a single-phase load: $V = 220\ \text{V} \pm 2\%$, $I = 10\ \text{A} \pm 1\%$ and $P = 500\ \text{W} \pm 2\%$. 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.17 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.18 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.19 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.20 **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.21 The dimensional equation for permeance (P) is expressed as $I^a M^b L^2 T^c$. Then value of $a + b - c$ is _____.

Answers Introduction

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

Explanations Introduction

1. (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.

2. (a)

Given, full scale reading = 200 V

Magnitude of limiting error of instrument is

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

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

3. (c)

- Sensitivity α $\dfrac{1}{\text{Deflection factor}}$
- Static sensitivity = $\dfrac{1}{I_{FSD}}$

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

4. (c)

$$P = I^2R$$

Limiting error is given as,

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

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

5. Sol.

$$\text{Span} = 2000\,^\circ\text{C} - 500\,^\circ\text{C}$$

$$= 1500\,^\circ\text{C}$$

$\therefore$ Temperature change

$$= \frac{0.125}{100} \times 1500$$

$$= 1.875\,^\circ\text{C}$$

6. Sol.

The magnitude of limiting error of the voltmeter = $0.02 \times 100 = 2$ 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

$$= 2.857\% + 3.75\%$$

$$= 6.607\% \approx 6.6\%$$

7. (b)

For first order instruments, transfer function is,

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

where, K = static sensitivity

T = time constant

8. (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.

9. (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.

10. (b)

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

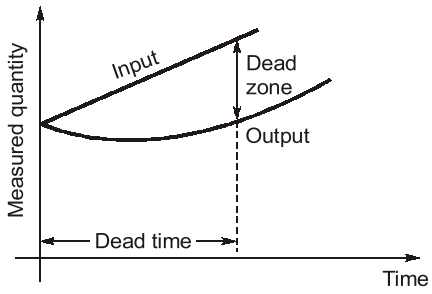
1. Deflecting force
2. Controlling force
3. Damping force

11. (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.

12. (b)

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



13. (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

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

Alternate solution:

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

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

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

14. (c)

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

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

15. (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.

16. Sol.

Given, $V = 220 \text{ V} \pm 2\%$

$I = 10 \text{ A} \pm 1\%$

$P = 500 \text{ W} \pm 2\%$

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

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

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

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

$$= 0.23 \pm 5\%$$

17. (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

18. (a)

A caesium standard or caesium beam standard is a primary frequency standard in which

ELECTROMAGNETIC THEORY

OBJECTIVE PRACTICE SETS

Page No. 211 - 288

1 CHAPTER
Vector Analysis

MCQ and NAT Questions

Q.1 If $\vec{G} = 15r\hat{a}_\phi$ then $\oint \vec{G} \cdot \vec{dl}$ over the circular path $r = 2$ m, $\theta = 30°$, $0 < \phi < 2\pi$ is
(a) 120π (b) 120
(c) 60π (d) 60

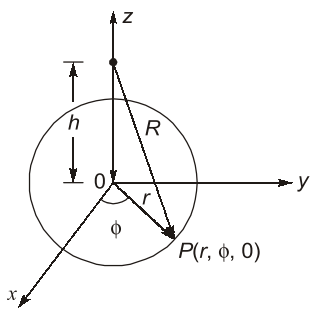
Q.2 Which of the following is true?
(a) $\text{Curl}(\vec{A} \cdot \vec{B}) = \text{Curl}\ \vec{A} + \text{Curl}\ \vec{B}$
(b) $\text{Div}\ (\vec{A} \cdot \vec{B}) = \text{Div}\ \vec{A} \cdot \text{Div}\ \vec{B}$
(c) $\text{Div}\ (\text{Curl}\ \vec{A}) = 0$
(d) $\text{Div}(\text{Curl}\ \vec{A}) = \Delta \cdot \vec{A}$

Q.3 Which of the following equations is correct?
1. $\hat{a}_x \times \hat{a}_x = |a_x|^2$
2. $(\hat{a}_x \times \hat{a}_y) + (\hat{a}_y \times \hat{a}_x) = 0$
3. $\hat{a}_x \times (\hat{a}_y \times \hat{a}_z) = \hat{a}_x \times (\hat{a}_z \times \hat{a}_y)$
4. $\hat{a}_r \cdot \hat{a}_\theta + \hat{a}_\theta \cdot \hat{a}_r = 0$

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

Q.4 Laplacian of a scalar function V is
(a) Gradient of V
(b) Divergence of V
(c) Gradient of the gradient of V
(d) Divergence of the gradient of V

Q.5 The unit vector $\vec{a}_R$ which points from $z = h$ on the z-axis towards $(r, \phi, 0)$ in cylindrical co-ordinates as shown below is given by



(a) $\dfrac{h\vec{a}_r - r\vec{a}_z}{\sqrt{r^2 + h^2}}$ (b) $\dfrac{r\vec{a}_r - h\vec{a}_z}{\sqrt{r^2 + h^2}}$
(c) $\dfrac{h\vec{a}_\phi - r\vec{a}_z}{\sqrt{r^2 + h^2}}$ (d) $\dfrac{r\vec{a}_z - h\vec{a}_\phi}{\sqrt{r^2 + h^2}}$

Q.6 Which of the following statements is not true of a phasor?
(a) It may be a scalar or a vector.
(b) It is a time dependent quantity.
(c) It is a complex quantity.
(d) All are true.

Q.7 The maximum space rate of change of the function which is in increasing direction of the function is known as
(a) curl of the vector function
(b) gradient of the scalar function
(c) divergence of the vector function
(d) Stokes theorem

Q.8 **Assertion (A):** Divergence of a vector function $\vec{A}$ at each point gives the rate per unit volume at which the physical entity is issuing from that point.
Reason (R): If some physical entity is generated or absorbed within a certain region of the field, then that region is known as source or sink respectively and if there are no sources or sinks in the field, the net outflow of the incompressible physical entity over any part of the region is zero. However, the net outflow is said to be positive, if the total strength of the sources are greater than the total strength of sink and vice-versa.
(a) Both A and R are true and R is a correct explanation of A.
(b) Both A and R are true but R is not a correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.9 Given a vector field $\vec{F}$. The Stoke's theorem states that,

(a) $\oint \vec{F}\cdot\vec{dl} = \iint(\vec{\nabla}\times\vec{F})\cdot\vec{ds}$

(b) $\oint \vec{F}\times\vec{dl} = \iint(\vec{\nabla}\cdot\vec{F})\,\vec{ds}$

(c) $\int \vec{F}\cdot\vec{dl} = \iint(\vec{\nabla}\times\vec{F})\cdot\vec{ds}$

(d) $\int \vec{F}\times\vec{dl} = \iint(\vec{\nabla}\cdot\vec{F})\,\vec{ds}$

Q.10 The vector $\vec{A}$ directed from (2, – 4, 1) to (0, –2, 0) in Cartesian coordinates is given by

(a) $-2\vec{a}_x + 2\vec{a}_y + \vec{a}_z$ (b) $-2\vec{a}_x + 2\vec{a}_y - \vec{a}_z$

(c) $-\vec{a}_x - 2\vec{a}_y + 2\vec{a}_z$ (d) $\vec{a}_x - 2\vec{a}_y - \vec{a}_z$

Q.11 The vector field given by

$\vec{A} = yz\vec{a}_x + xz\vec{a}_y + xy\vec{a}_z$ is

(a) rotational and solenoidal
(b) rotational but not solenoidal
(c) irrotational and solenoidal
(d) irrotational but not solenoidal

Q.12 If $\vec{A} = \dfrac{\vec{a}_x}{\sqrt{x^2+y^2}}$, then the value of $\nabla\cdot\vec{A}$ at (2, 2, 0) will be

(a) –0.0884 (b) 0.0264
(c) –0.0356 (d) 0.0542

Q.13 If $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$, then the value of $\vec{i}\times(\vec{r}\times\vec{i}) + \vec{j}\times(\vec{r}\times\vec{j}) + \vec{k}\times(\vec{r}\times\vec{k})$ is

(a) $\vec{r}$ (b) $2\vec{r}$
(c) $3\vec{r}$ (d) $6\vec{r}$

Q.14 What is the value of constant *b* so that the vector

$\vec{V} = (x+3y)\vec{i} + (y-2x)\vec{j} + (x+bz)\vec{k}$

is solenoidal?

(a) 2 (b) –1
(c) 3 (d) –2

Q.15 **Assertion (A):** The Gauss's divergence theorem permits us to express certain integrals by means of surface integrals.

Reason (R): Gauss's divergence theorem states that "the surface integral of the curl of a vector field taken over any surface *s* is equal to the line integral of the vector field around the closed periphery (contour) of the surface.

(a) Both A and R are true and R is a correct explanation of A.
(b) Both A and R are true but R is not a correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.16 Which of the following option is not correct?

(a) A vector field $\vec{A}$ is solenoid, if $\nabla\cdot\vec{A} = 0$

(b) A vector field $\vec{A}$ is irrotational, if $\nabla\times\vec{A} = 0$

(c) A vector field *V* is harmonics, if $\nabla^2 V \neq 0$

(d) All options are correct

Q.17 Which of the following statements is not true regarding vector algebra?

(a) Dot product of like unit vector is unity.
(b) Dot product of unlike unit vector is zero.
(c) Cross product of two like unit vectors is a third unit vector having positive sign for normal rotation and negative for reverse rotation.
(d) All the above statements are true.

Q.18 A rigid body is rotating with an angular velocity of ω where, $\vec{\omega} = \omega_x\vec{i} + \omega_y\vec{j} + \omega_z\vec{k}$ and *v* is the line velocity. If $\vec{r}$ is the position vector given by $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$, then the value of curl $\vec{v}$ will be equal to

(a) $1/2\,\omega$ (b) ω
(c) $1/3\,\omega$ (d) $2\,\omega$

Q.19 Which of the following identity is not true?

(a) $\vec{A}(\vec{B}\cdot\vec{C}) = (\vec{A}\cdot\vec{C})\vec{B} - (\vec{A}\cdot\vec{B})\,\vec{C}$

(b) $\nabla\cdot(\nabla\times\vec{A}) = 0$

(c) $\nabla\times\nabla\varphi \neq 0$

(d) None of the above

Q.20 The value of divergence of a vector quantity $\vec{A} = 4xy\,\hat{a}_x + xz\,\hat{a}_y + xyz\,\hat{a}_z$ at a point *P*(1, –2, 3) will be

(a) 6 (b) –16
(c) –10 (d) 12

Q.21 Laplace equation in cylindrical coordinates is given by

(a) $\nabla^2 V = \dfrac{1}{r}\dfrac{\partial}{\partial r}\left(\dfrac{r\partial V}{\partial r}\right) + \dfrac{1}{r^2}\left(\dfrac{\partial^2 V}{\partial\phi^2}\right) + \dfrac{\partial^2 V}{\partial z^2} = 0$

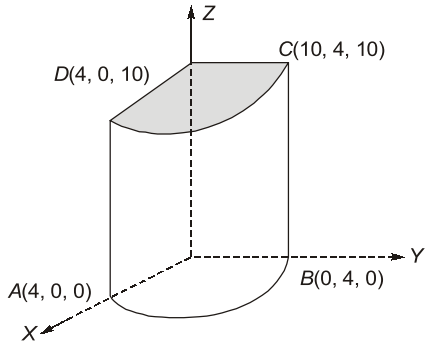
(b) $\nabla^2 V = \dfrac{\partial^2 V}{\partial x^2} + \dfrac{\partial^2 V}{\partial y^2} + \dfrac{\partial^2 V}{\partial z^2}$

(c) $\nabla^2 V = \frac{-\rho}{\varepsilon}$

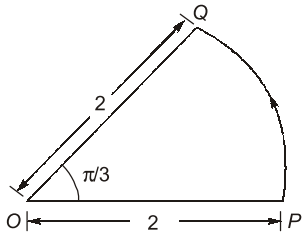
(d) $\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(\frac{r^2 \partial V}{\partial r}\right) + \left(-\frac{1}{r^2 \sin\theta}\right)\frac{\partial}{\partial \theta}$

$\left(\sin\theta \frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2 \sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = 0$

Q.22 Consider the object shown in figure below calculate. The surface area *ABCD*,



Q.23 If $\vec{A} = \hat{a}_\rho + \hat{a}_\phi + \hat{a}_z$, the value of $\oint \vec{A} \cdot \vec{dl}$ around the closed circular quadrant shown in the given figure is _____.



Q.24 Given, $W = x^2y^2 + xy$, compute ∇W and the direction derivative $d\omega/dl$ in the direction,

$\vec{A} = 3\hat{a}_x + 4\hat{a}_y + 12\hat{a}_z$ at (2, –1, 0)

Q.25 If $\vec{E}$ is the electric field intensity then $\vec{\nabla} \times (\vec{\nabla} \cdot A)$ is equal to

(a) $\vec{E}$ (b) $|\vec{E}|$

(c) Null vector (d) zero

Q.26 Divergence of the vector field,
$V(x, y, z) = (x \sin xy)\hat{i} - (y \sin xy)\hat{j} + \sin z^2 \hat{k}$ is
Divergence = $2z \cos z^2$

(a) $2z \cos z^2$ (b) $\sin xy + 2z \cos z^2$

(c) $x \sin xy - \cos z$ (d) none of these

Q.27 The line integral of the vector field
$\vec{F} = 5x\vec{i} + 3y\hat{j} + x^2 z\hat{k}$ along a path from (0, 0, 0) to (1, 1, 1) parameterized by (t, t^2, t) is

Q.28 If the vector V given below is irrotational, then the values of a, b and c will be respectively

$V = (x + 2y + az)\vec{i} + (bx - 3y - z)\vec{j} + (4x + cy + 2z)\vec{k}$

(a) $a = 4$, $b = 2$ and $c = -1$

(b) $a = 2$, $b = -1$and $c = 4$

(c) $a = 4$, $b = -1$ and $c = 2$

(d) $a = 2$, $b = 4$ and $c = -1$

Q.29 What is the value of $\iint_s \vec{F} \cdot d\vec{s}$, where $\vec{F} = 4xz\vec{i}_1 - y^2\vec{i}_2 + yz\vec{i}_3$?

Here, s is the surface bounded by $x = 0$, $x = 1$, $y = 0$, $y = 1$, $z = 0$, $z = 1$ and $\vec{i}_1, \vec{i}_2, \vec{i}_3$ are unit vectors along x, y and z axes respectively.

(a) 1/2 (b) 5/2

(c) 2 (d) 3/2

Q.30 Given a vector $\vec{A} = 30e^{-r}\hat{a}_r - 2z\hat{a}_z$ in cylindrical co-ordinates. If a volume is enclosed by $r = 2$, $\phi = 2\pi$ and $z = 5$ then $\int (\nabla \cdot \vec{A}) dv$ = _____ .

Q.31 If $\vec{r} = x\vec{I}_x + y\vec{I}_y + z\vec{I}_z$, then which of the following relation will hold true?

(a) $\nabla \vec{r} = 3$ (b) $\nabla \times \vec{r} = 0$

(c) Both (a) and (b) (d) Neither (a) nor (b)

Q.32 If $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$ is the position vector of point (x, y, z), then $\nabla(In|r|)$ is

(a) $|r|\vec{r}$ (b) $|r|^2\vec{r}$

(c) $\frac{\vec{r}}{|r|}$ (d) $\frac{\vec{r}}{|r|^2}$

Q.33 If $\vec{B} = x^2 y\,\hat{a}_x + (2x^2 + y)\hat{a}_y - (y - z)\hat{a}_z$
then $\nabla(\nabla \cdot B)$ is

(a) $2\hat{a}_x + 2xy\,\hat{a}_y$ (b) $2y\,\hat{a}_x + 2x\,\hat{a}_y$

(c) $x\,\hat{a}_x + y\,\hat{a}_y$ (d) $xy\,\hat{a}_x + xy\,\hat{a}_y$

Q.34 If $\vec{H} = R\sin\theta\,\hat{a}_\phi$ (in spherical coordinates) then the magnitude of curl of the vector field H at the origin is _____.

Answers Vector Analysis

1. (c)	2. (c)	3. (d)	4. (d)	5. (b)	6. (a)	7. (b)	8. (a)	9. (a)
10. (b)	11. (c)	12. (a)	13. (b)	14. (d)	15. (c)	16. (c)	17. (c)	18. (d)
19. (c)	20. (c)	21. (a)	22. (62.83)	23. (5.14)	24. (–1.15)	25. (d)	26. (a)	27. (3.75)
28. (a)	29. (d)	30. (129.43)		31. (c)	32. (d)	33. (b)	34. (2)	35. (1244)
36. (b)	37. (a)	38. (5)	39. (c)	40. (a)	41. (d)	42. (a)	43. (d)	44. (b)
45. (3)	46. (0.33)	47. (0.5)	48. (0.5)	49. (a,c,d)	50. (b,d)	51. (b,c)	52. (c,d)	53. (a,d)
54. (b,c,d)		55. (b,c)						

Explanations Vector Analysis

1. (c)

For spherical coordinate systems,

$$\vec{dl} = r\sin\theta\, d\phi\, \hat{a}_\phi$$

$$\oint \vec{G}\cdot\vec{dl} = \int_0^{2\pi} 15\hat{ra}_\phi \cdot r\sin\theta\, d\phi\, \hat{a}_\phi$$

$$= 15\cdot r^2\cdot \sin\theta(2\pi)$$

$$= 15\cdot(2)^2 \times \sin 30°(2\pi)$$

$$\oint \vec{G}\cdot\vec{dl} = 60\pi$$

2. (c)

Divergence (Curl $\vec{A}$) = 0

3. (d)

$$(\hat{a}_x \times \hat{a}_x) = 0$$

Since cross product with same vector is zero because $\theta = 0$ so $\sin\theta = 0$

$$\hat{a}_x \times \hat{a}_y = \hat{a}_z$$

$$\hat{a}_y \times \hat{a}_x = -\hat{a}_z$$

$$(\hat{a}_x \times \hat{a}_y) + (\hat{a}_y \times \hat{a}_x) = \hat{a}_z + (-\hat{a}_z) = 0$$

4. (d)

$$\nabla^2 V = \bar{\nabla}\cdot(\bar{\nabla}V)$$

= divergence of gradient of V

5. (b)

Let the unit vector be given by $\vec{a}_R$.

Now, $\vec{R}$ = Difference of two vectors

$$= r\vec{a}_r - h\vec{a}_z$$

$$\therefore \text{Unit vector, } \vec{a}_R = \frac{\vec{R}}{|\vec{R}|} = \frac{r\vec{a}_r - h\vec{a}_z}{\sqrt{r^2+h^2}}$$

6. (a)

A phasor is always a vector quantity.

7. (b)

Gradient of a scalar;

∇A = maximum rate of change of scalar A with respect to given coordinates system.

8. (a)

Both assertion and reason are true and reason is the correct explanation of assertion. Reason is the physical interpretation of divergence.

10. (b)

The vector $\vec{A}$ is given as

$$\vec{A} = (0-2)\vec{a}_x + [-2-(-4)]\vec{a}_y + (0-1)\vec{a}_z$$

x (2, –4, 1) $\xrightarrow{\vec{A}}$ y (0, –2, 0)

$$= -2\vec{a}_x + 2\vec{a}_y - \vec{a}_z$$

11. (c)

The vector field $\vec{A}$ will be irrotational, if $\nabla \times \vec{A} = 0$.

Now, $\nabla \times \vec{A} = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ yz & xz & xy \end{vmatrix}$

$$= \left[\frac{\partial}{\partial y}(xy) - \frac{\partial}{\partial z}(xz)\right]\vec{a}_x + \left[\frac{\partial}{\partial x}(xy) - \frac{\partial}{\partial z}(yz)\right]\vec{a}_y + \left[\frac{\partial}{\partial x}(xz) - \frac{\partial}{\partial y}(yz)\right]\vec{a}_z$$

$$= [x-x]\vec{a}_x + [y-y]\vec{a}_y + [z-z]\vec{a}_z$$
$$= 0$$

Hence, $\vec{A}$ is irrotational.

The vector field $\vec{A}$ will be solenoidal, if $\nabla \cdot \vec{A} = 0$

Here,

$$\nabla \cdot \vec{A} = \left(\vec{a}_x \frac{\partial}{\partial x} + \vec{a}_y \frac{\partial}{\partial y} + \vec{a}_z \frac{\partial}{\partial z}\right) \cdot (yz\vec{a}_x + xz\vec{a}_y + xy\vec{a}_z)$$

$$= \vec{a}_x \cdot \vec{a}_x \frac{\partial}{\partial x}(yz) + \vec{a}_y \cdot \vec{a}_y \frac{\partial}{\partial y}(xz) + \vec{a}_z \cdot \vec{a}_z \frac{\partial}{\partial z}(xy)$$
$$= 0 + 0 + 0 = 0$$

Hence, $\vec{A}$ is solenoidal.

12. (a)

Given, $\vec{A} = \dfrac{1}{\sqrt{x^2+y^2}}\vec{a}_x$

$$\therefore \quad \nabla \cdot \vec{A} = \frac{\partial}{\partial x}(A_x) + \frac{\partial}{\partial y}(A_y) + \frac{\partial}{\partial z}(A_z)$$

$$= \frac{\partial}{\partial x}\left(\frac{1}{\sqrt{x^2+y^2}}\right) + 0 + 0$$

$$= \frac{\partial}{\partial x}(x^2+y^2)^{-1/2}$$

$$= -\frac{1}{2}(x^2+y^2)^{-3/2} \cdot 2x$$

$$= \nabla \cdot \vec{A} = -\frac{x}{\sqrt{(x^2+y^2)}(x^2+y^2)}$$

Now, $(\nabla \cdot \vec{A})_{2,2,0} = -\dfrac{2}{\sqrt{(2^2+2^2)}\cdot(2^2+2^2)}$

$$= -\frac{2}{\sqrt{8}.8} = -0.0884$$

13. (b)

Given, $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$

$\therefore \quad \vec{r} \times \vec{i} =$

$(x\vec{i} + y\vec{j} + z\vec{k}) \times \vec{i} = -y\vec{k} + z\vec{j}$

Also, $\vec{i} \times (\vec{r} \times \vec{i}) =$

$\vec{i} \times (-y\vec{k} + z\vec{j}) = \vec{j}\,y + z\vec{k}$

Similarly, $\vec{j} \times (\vec{r} \times \vec{j}) = \vec{i}x + \vec{k}z$

and $\vec{k} \times (\vec{r} \times \vec{k}) = \vec{i}x + \vec{j}y$

Thus, $\vec{i} \times (\vec{r} \times \vec{i}) + \vec{j} \times (\vec{r} \times \vec{j}) + \vec{k} \times (\vec{r} \times \vec{k})$

$$= 2(x\vec{i} + y\vec{j} + z\vec{k}) = 2\vec{r}$$

14. (d)

Since vector $\vec{V}$ is solenoidal, therefore

$$\nabla \cdot V = 0$$

$$\therefore \left[\vec{i}\frac{\partial}{\partial x} + \vec{j}\frac{\partial}{\partial y} + \vec{k}\frac{\partial}{\partial z}\right] \cdot \begin{bmatrix} \vec{i}(x+3y) + \vec{j}(y-2x) \\ +\vec{k}(x+bz) \end{bmatrix} = 0$$

or, $[1 + 1 + b] = 0$ or $b = -2$

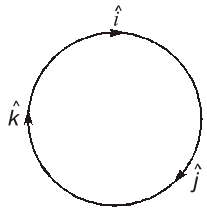
15. (c)

Reason is a statement of stroke's theorem not that of Gauss's divergence theorem.

16. (c)

A scalar field V is harmonics, if $\nabla^2 V = 0$. Hence, option (c) is not correct.

17. (c)



Option (c) is not correct because cross product of two unlike vectors is a third unit vector having positive sign for normal rotation and negative for reverse rotation while cross product of two like unit vectors is zero.

18. (d)

Taking the curl, we have:

$$\nabla \times \vec{V} = \nabla \times \vec{\omega} \times \vec{r} \text{ (Since } \vec{V} = \vec{\omega} \times \vec{r}\text{)}$$

or, $$\nabla \times \vec{V} = \left(\vec{i}\frac{\partial}{\partial x} + \vec{j}\frac{\partial}{\partial y} + \vec{k}\frac{\partial}{\partial z}\right) \times \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \omega_x & \omega_y & \omega_z \\ x & y & z \end{vmatrix}$$

$$= \left[\vec{i}\frac{\partial}{\partial x} + \vec{j}\frac{\partial}{\partial y} + \vec{k}\frac{\partial}{\partial z}\right] \times [\vec{i}(\omega_y z - \omega_z y) + \vec{j}(\omega_z x - \omega_x z) + \vec{k}(\omega_x y - \omega_y x)]$$

$$= (\vec{i} \times \vec{j})\frac{\partial}{\partial x}(\omega_z x - \omega_x z) + (\vec{i} \times \vec{k})\frac{\partial}{\partial x}(\omega_x y - \omega_y x) + (\vec{j} \times \vec{i})\frac{\partial}{\partial y}(\omega_y z - \omega_z y) + (\vec{j} \times \vec{k})\frac{\partial}{\partial y}(\omega_x y - \omega_y x) + (\vec{k} \times \vec{i})\frac{\partial}{\partial z}(\omega_y z - \omega_z y) + (\vec{k} \times \vec{j})\frac{\partial}{\partial z}(\omega_z x - \omega_x z)$$

$$= \vec{k}(\omega_z - 0) - \vec{j}(0 - \omega_y) - \vec{k}(0 - \omega_z) + \vec{i}(\omega_x - 0) + \vec{j}(\omega_y - 0) - \vec{i}(0 - \omega_x)$$