MADE EASY PUBLICATIONS

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ELECTRICAL ENGINEERING

Objective Practice Sets

Electromagnetic Theory

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

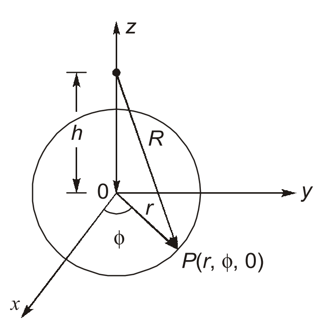
Q.2 Which of the following is true?
(a) $\text{Curl}(\vec{A}\cdot\vec{B}) = \text{Curl}\,\vec{A} + \text{Curl}\,\vec{B}$
(b) $\text{Div}\,(\vec{A}\cdot\vec{B}) = \text{Div}\,\vec{A}\cdot\text{Div}\,\vec{B}$
(c) $\text{Div}\,(\text{Curl}\,\vec{A}) = 0$
(d) $\text{Div}(\text{Curl}\,\vec{A}) = \Delta\cdot\vec{A}$

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,

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,

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

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

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

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

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

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)

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

$$= \text{divergence of gradient of V}$$

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.

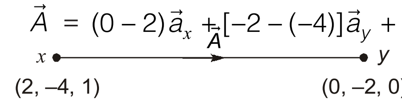
8. (a)

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

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



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

11. (c)

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

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

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

2 CHAPTER Electrostatics

MCQ and NAT Questions

Q.1 What is the electric field strength at a distance of 200 mm from a charge of 2×10^{-6} Coulomb in vacuum?

(a) 450 kV/m (b) 236 kV/m
(c) 525 kV/m (d) 328 kV/m

Q.2 Two point charges of 3×10^{-9} C and -2×10^{-9} C are spaced two meters apart. What is the electric field at a point which is one meter from each of the two point charges?

(a) 11 V/m (b) 5 V/m
(c) 9 V/m (d) 6 V/m

Q.3 Five equal point charges of $Q = 20 \times 10^{-9}$ C, are placed at x = 2,3,4,5 and 6 cm. The electric potential at origin will be

(a) 416 V (b) 128 V
(c) 325 V (d) 261 V

Q.4 The energy stored per unit volume in an electric field (with usual notations) is given by

(a) $\frac{1}{2}\varepsilon H^2$ (b) $\frac{1}{2}\varepsilon H$
(c) $\frac{1}{2}\varepsilon E^2$ (d) εE^2

Q.5 **Assertion (A):** If all the points in space which have the same potential are jointed, then equipotential surfaces are obtained.
Reason (R): The field and the equipotential surfaces are orthogonal to each other.

(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.6 The electric field strength at a point in front of an infinite sheet of charge is

(a) independent of the distance of the point from the sheet.
(b) inversely proportional to the distance of the point from the sheet.
(c) inversely proportional to the square of distance of the point from the sheet.
(d) none of the above

Q.7 Which one of the following pairs is NOT correctly matched?

(a) Gauss theorem: $\oint_s \vec{D}\cdot d\vec{s} = \oint_s \nabla\cdot\vec{D}\,dV$
(b) Gauss's law: $\oint \vec{D}\cdot d\vec{s} = \int \rho\, dV$
(c) Coulomb's law: $V = -\frac{d\phi_m}{dt}$
(d) Stoke's theorem: $\oint_L \vec{E}\cdot d\vec{l} = \iint_s (\nabla\times\vec{E})\cdot d\vec{s}$

Q.8 Electric field intensity due to line charge of infinite length is

(a) $\frac{\rho_L}{2\pi\epsilon r}$ (b) $\frac{\rho_L}{4\pi\epsilon r}$
(c) $\frac{\rho_L}{\pi\epsilon r}$ (d) $\frac{2\rho_L}{\pi\epsilon r}$

Q.9 Consider the following statements associated with equipotential surface:

1. Potential is same everywhere.
2. No current flows on this surface.
3. Work done in moving charge from one point to another is zero.
4. Potential is different everywhere.

Which of the above statements is/are not correct?

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

Q.10 What is the value of total electric flux coming out of a closed surface?

Answers Electrostatics

1. (a)	2. (c)	3. (d)	4. (c)	5. (b)	6. (a)	7. (c)	8. (a)
9. (c)	10. (c)	11. (b)	12. (a)	13. (c)	14. (d)	15. (b)	16. (a)
17. (d)	18. (a)	19. (b)	20. (b)	21. (c)	22. (d)	23. (c)	24. (c)
25. (b)	26. (c)	27. (d)	28. (b)	29. (d)	30. (a)	31. (c)	32. (b)
33. (b)	34. (b)	35. (b)	36. (c)	37. (c)	38. (a)	39. (a)	40. (d)
41. (d)	42. (b)	43. (a)	44. (a)	45. (d)	46. (c)	47. (c)	48. (b)
49. (b)	50. (d)	51. (b)	52. (c)	53. (a)	54. (d)	55. (a)	56. (d)
57. (c)	58. (d)	59. (8.24)	60. (22.24)	61. (0.1)	62. (0.885)	63. (4)	64. (a)
65. (b)	66. (d)	67. (b)	68. (d)	69. (d)	70. (c)	71. (d)	72. (b)
73. (a)	74. (c)	75. (d)	76. (c)	77. (c)	78. (c)	79. (d)	80. (c)
81. (c)	82. (a)	83. (a)	84. (d)	85. (a)	86. (c)	87. (a)	88. (108)
89. (a)	90. (0.22)	91. (885)	92. (50)	93. (48)	94. (13.66)	95. (–0.63)	96. (2.46)
97. (33.27)	98. (9.8)	99. (450)	100. (72.00)	101. (–40)	102. (150.31)	103. (1.125)	104. (1579.2)
105. (–50.02)	106. (1.28)	107. (70.56)	108. (434.60)	109. (0.156)	110. (6)	111. (b,d)	112. (a,b,c)
113. (a,b,d)	114. (a,c,d)	115. (a,b)	116. (a,b,d)	117. (c,d)	118. (b,c)	119. (a,d)	
120. (a,b,c,d)							

Explanations Electrostatics

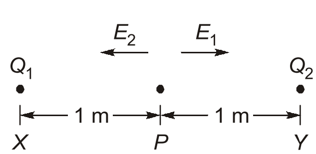
1. (a)

$$E = \frac{Q}{4\pi \epsilon_0 r^2}\ \text{V/m}$$

$$= \frac{9\times10^9 \times 2\times10^{-6}}{(0.2)^2}$$

$$= \frac{18}{0.04}\times10^3\ \text{V/m} = 450\ \text{kV/m}$$

2. (c)



Given, $Q_1 = +3\times10^{-9}$ C

and $Q_2 = -2\times10^{-9}$ C

Here, $E_1 = \frac{Q_1}{4\pi \epsilon_0 r^2} = \frac{9\times10^9\times3\times10^{-9}}{1^2}$

$= 27$ V/m (Along PY)

and $E_2 = \frac{Q_2}{4\pi \epsilon_0 r^2} = \frac{9\times10^9\times(-2\times10^9)}{1^2}$

$= -18$ V/m (Along *PX*)

Hence, electric field intensity at point *P* is

$$E = E_1 + E_2 = 27 - 18 = 9\ \text{V/m}$$

3. (d)

Electric potential at origin is given as

$$V = \frac{1}{4\pi \epsilon_0}\left[\frac{Q_1}{r_1}+\frac{Q_2}{r_2}+\frac{Q_3}{r_3}+\frac{Q_4}{r_4}+\frac{Q_5}{r_5}\right]$$

Since, $Q_1 = Q_2 = ...Q_5$

$= Q = 20\times10^{-9}$ C

Therefore,

$$V = 9\times10^9\times20\times10^{-9}\left[\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}\right]$$

$$= 180\left[\frac{30+20+15+12+10}{60}\right]\ \text{Volts}$$

$$= 180\times\frac{87}{60}\ \text{V} = 3\times87 = 261\ \text{Volts}$$

4. (c)

Energy density in electric field (J/m^3) $= \frac{1}{2}\varepsilon E^2$

$= \frac{1}{2}D\cdot E$

5. (b)

Both assertion and reason are individually true. However, the correct reason for assertion is that equipotential surfaces are those on which the