TE262: ELECTROMAGNETIC FIELDS

TUTORIAL QUESTIONS

Using dot product, show that

1. $\vec{A} = (\hat{x}2 + \hat{y}4 + \hat{z}5)\ and\ \vec{B} = (\hat{x}2 + \hat{y}4 - \hat{z}4)$ are perpendicular.

2.Show that $\vec{C} = (-\hat{x}2 + \hat{y})$ is perpendicular to both $\vec{A}\ and\ \vec{B}$ of problem (1).

3. Find the angle θ between $\vec{A} = (\hat{x}4 - \hat{y}2 - \hat{z}3)\ and\ \vec{B} = (\hat{x}3 - \hat{y}4)$, using the cross product.

4. A velocity vector field $\vec{v} = \hat{x}5x^2 + \hat{y}2y^2 - \hat{z}4z^2(ms^{-1})$ found at $P_{rec}(1,1,0)$.Find the projection of $\vec{v}$ onto $\hat{r_c}$ direction.

5. Given two points $\mathrm{C}(-3,2,1)$ and $\mathrm{D}(r_s = 5, \theta = 20^o, \emptyset = 70^o)$. Find

(a). The spherical coordinates of C;

(b). The Cartesian (rectangular coordinates) of D

(c). The distance from C to D

6. Find the force $\vec{F}_2$, in vacuum on a point charge $Q_2 = -10^{-4}C$ due to a point charge $Q_1 = 3x10^{-4}C$ when Q_2 is at $N(2,0,5)$ and Q_1 is at $M(1,2,3)$

7. A positive charge Q_1 of $10^{-9}C$ is located on the y-axis at $y = 2$, and a charge Q_2 of $-10^{-9}C$ is located on the y-axis at $y = -2$. Find the total force on a small positive test charge Q_t located at $(10,0,0)$.

8. Find the electric field intensity $\vec{E}$ at $P_{rec}(2,4,5)$ due to a point charge $Q = 2x10^{-5}C$, located at $P_{rec}(0,1,2)$ in vacuum.

9. Find the total electric field at the origin due to a $10^{-8}C$ charge located at $P_{rec}(0,4,4)$ and a $-0.5 \times 10^{-8}C$ charge at $P_{rec}(4,0,2)$.

10. Evaluate $\nabla \cdot \vec{D}$ for the following fields

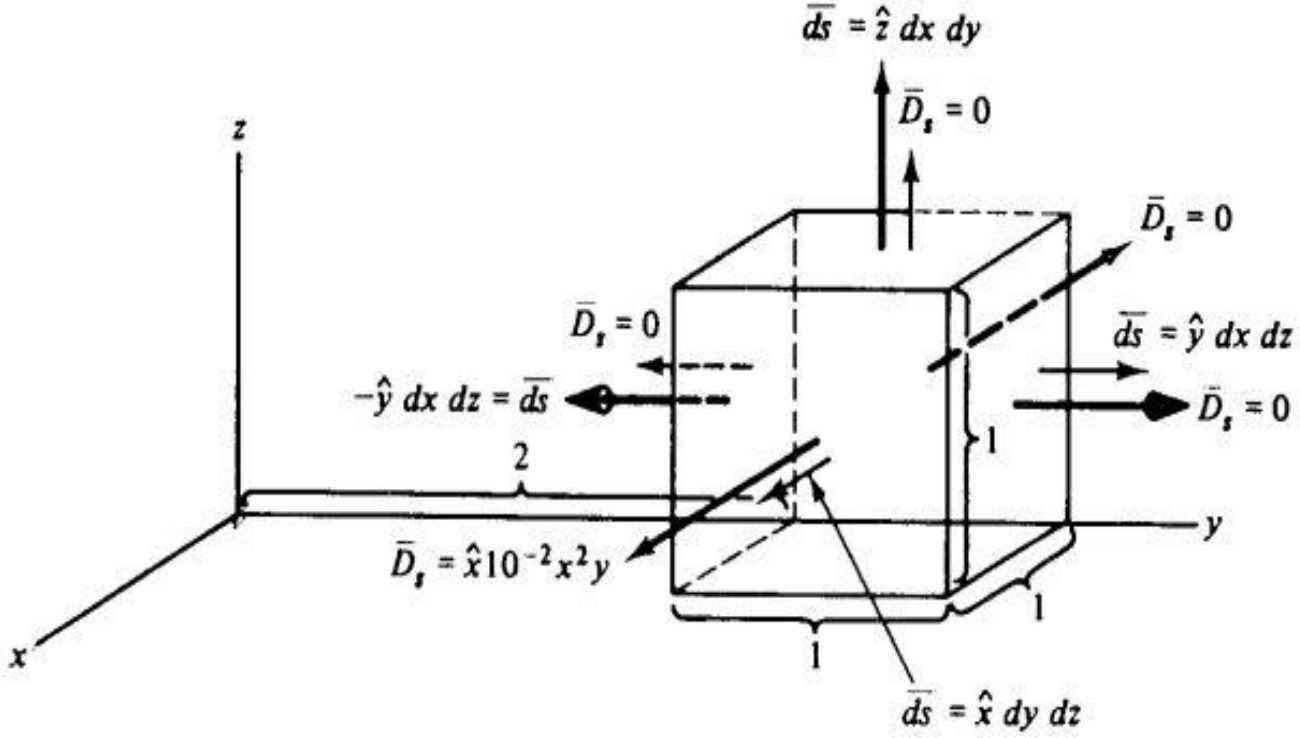
(a) $\hat{x}kx$

(b) $\hat{x}kx^2$

(c) $\hat{x}kx^2 + \hat{z}kxz$

Find the ρ_v at the origin for the fields in (a) and (c) above.

11. Evaluate both sides of the divergence theorem equation when $\vec{D} = \hat{x}10^{-2}x^2y\ (Cm^{-2})$ and the Gaussian surface is a cube measuring 1m on each side as shown.



12. Evaluate the potential V_{ab} in an electrostatic field $\vec{E} = \hat{x}2x^2 + \hat{y}y + \hat{z}z^3$. When the path of integration is A series of straight lines from $b(0,3,-2)\ to\ (1,3,-2)\ to\ (1,3,0)\ to\ (0,3,0)\ to\ a\ (0,0,0)$

13. Find the capacitance of a parallel plate capacitor whose plates are separated one centimeter (1cm) and whose surface area equals $1cm^2$. Assume air dielectric and neglect $\vec{E}$ field fringing.

13. A plane wave travelling in a lossless dielectric medium has an electric given as $E_x = E_0 \cos(\omega t - \beta z)$ with a frequency of 5.0 GHz and a wavelength of 3.0 cm. Determine the phase constant, the phase velocity, the relative permittivity of the medium, and the wave impedance.

MCQs

1. Gradient of a function is a constant.
   True/False.

2. Divergence of gradient of a vector function is equivalent to
a) Laplacian operation
b) Curl operation
c) Double gradient operation
d) Null vector

3. The gradient of xi + yj + zk is
a) 0
b) 1
c) 2
d) 3

4. Curl of gradient of a vector is
a) Unity
b) Zero
c) Null vector
d) Depends on the constants of the vector

5. The gradient can be replaced by which of the following?
a) Maxwell equation
b) Volume integral
c) Differential equation
d) Surface integral

6. When gradient of a function is zero, the function lies parallel to the x-axis. True/False.

7. Determine the divergence of $F = 30\,i + 2xy\,j + 5xz^2\,k$ at (1,1,-0.2) and state the nature of the field.

a) 1, solenoidal

b) 0, solenoidal

c) 1, divergent

d) 0, divergent

8. The curl of a curl of a vector gives a

a) Scalar

b) Vector

c) Zero value

d) Non zero value

9. State whether the vector $E = yz\,i + xz\,j + xy\,k$ is rotational or irrotational.

10. Which of the following Maxwell equations use curl operation?

a) Maxwell 1st and 2nd equation

b) Maxwell 3rd and 4th equation

c) All the four equations

d) None of the equations