SET A SOLUTIONS

Ans 1.

E= = = 6 V/m

OR

Ans 1.

Poisson’s Equation

Laplace Equation( when charge density p=0)

Ans 2.

Continuity equation can be derived from [Gauss' Law](http://www.maxwells-equations.com/gauss/law.php) and [Ampere's Law](http://www.maxwells-equations.com/ampere/amperes-law.php).

The equation states that the [divergence](http://www.maxwells-equations.com/divergence.php) of the [curl](http://www.maxwells-equations.com/curl/curl.php) of any [vector field](http://www.maxwells-equations.com/vector-functions.php) is always zero:

If we apply the [divergence](http://www.maxwells-equations.com/divergence.php) to both sides of Ampere's Law, then we obtain:

If we apply Gauss' Law to rewrite the divergence of the [Electric Flux Density (**D**)](http://www.maxwells-equations.com/density/electric-flux.php), we have derived the continuity equation:

|  |  |
| --- | --- |
|  |  |

The left side of the equation is the divergence of the [Electric Current Density (J)](http://maxwells-equations.com/density/current.php). This is a measure of whether current is flowing into a volume (i.e. the divergence of J is positive if more current leaves the volume than enters).

OR

Ans 2.

For a line charge in cylindrical coordinates ,

E=

Then = 0

Ans 3. dS

D

dS

D D

dS

Now calculating–

The first and second integrals are equal and opposite to each other and hence integrals vanish.

Q== D = D (2πrL)

Q= L = D (2πrL)

D=

E=

OR

Ans 3.

-

=0

V= -

- ; - ; -

E= -

Ans 4.

A=

+

+

= 2xz- 4y+ at (1,-1,1)

= 2+4+1

=7

SET B

Ans 1:

V= =

= = 261 V

OR

Ans 1:

Gauss’s law states that the total electric flux Ψ through any closed surface is equal to the total charge enclosed by that surface.

Thus Ψ=

Total charge enclosed

From divergence theorem {} so above equation becomes

- Differential form of Gauss law and also first equation of Maxwell.

Ans 2:

Stoke’s Theorem: It states that the outward [flux](https://en.wikipedia.org/wiki/Flux) of a vector field through a closed surface is equal to the [line integral](https://en.wikipedia.org/wiki/Volume_integral) of the [field](https://en.wikipedia.org/wiki/Divergence) over the region.

Let S be an oriented surface with a simple, closed boundary C. We use the positive orientation for C, meaning as you walk around C.

Divergence theorem : It states that the outward [flux](https://en.wikipedia.org/wiki/Flux) of a vector field through a closed surface is equal to the [volume integral](https://en.wikipedia.org/wiki/Volume_integral) of the [divergence](https://en.wikipedia.org/wiki/Divergence) over the region inside the surface.

Let E be a simple solid region and let S be the boundary of E, given with positive (outward) orientation. Then

= 2x+z

OR

Ans 2 :

Ψ = Q = C

Ans 3.

I= =

= 2π .

= 7.51 mA

OR

Ans 3.

To determine the boundary conditions , we use Maxwell and Gauss’s Laws ,

Also E can be decomposed into two orthogonal components as

E= where these are tangential and normal components

2. Fields inside conductor are zero .

Boundary condition for tangential component of electric field:

Dielectric

Perfect Conductor

Area (abcd)enclosed is infinitely small.

The line integral across the width will be 0 as the lengths tend to zero. The line integral inside the conductor will be zero as E inside the electric field is zero.

So we are left with one length and hence

Now calculating the normal component –

Integral for side is zero as height is infinitesimal small. Integral for bottom is zero as inside the conductor surface D=0. Only left is integral for top side –

Ans 4.

The method of images is used to determine V, E , D and p due to charges in the presence of conductors. The image theory states that a given charge configuration above an infinite grounded perfect conducting plane may be replaced by charge configuration itself , its image and an equipotential surface in place of conducting plane. Two conditions must be satisfied by the image charge-

1. The image charge must be located in the conducting region.
2. The image charge must be located such that on the conducting surface the potential is zero or constant.

In method of images the actual electrification of the surface is replaced by one or more fictitious point charges in the region where the field or potential is not desired. For example the method of images suggest that for a point charge +Q at a point (0,0,d) an exactly equal and opposite charge –Q is assumed to exist at the point (0,0,-d); replacing the conducting plane by an equipotential surface with zero potential.

We can easily find the scalar potential for this problem, since we know where all the charges are located. We get

|  |
| --- |
| \begin{displaymath} \phi_{\rm analogue} (x, y, z) = \frac{1}{4\pi \epsilon_0} \... ...{x^2+y^2+(z-d)^2}}- \frac{q}{\sqrt{x^2+y^2+ (z+d)^2}}\right\}. \end{displaymath} |

In this case,

|  |  |
| --- | --- |
| \begin{displaymath} E_\perp = E_z(z=0_+) = - \frac{\partial \phi(z=0_+)}{\partial z} = - \frac{\partial \phi_{\rm analogue}(z=0_+)}{\partial z}, \end{displaymath} |  |

so

|  |  |
| --- | --- |
| \begin{displaymath} \sigma = - \epsilon_0 \frac{\partial\phi_{\rm analogue}(z=0_+)}{\partial z}. \end{displaymath} |  |

|  |  |
| --- | --- |
| \begin{displaymath} \frac{\partial\phi}{\partial z} = \frac{q}{4\pi  \epsilon_0... ...-d)^2]^{3/2}} + \frac{(z+d)}{[x^2+y^2+(z+d)^2]^{3/2}}\right\}, \end{displaymath} |  |

so

|  |  |
| --- | --- |
| \begin{displaymath} \sigma(x,y) = - \frac{q d}{2\pi  (x^2+y^2+d^2)^{3/2}}. \end{displaymath} |  |