09/05/25

Date: / / Page no:

Electrostatics :-

Electrostatics in vacuum

(M) **Scalar Quantity :-** for E.g: Distance, Speed, Energy

This quantities are represented by only magnitude

(M&D) **Vector Quantity :-** for E.g. force, Momentum, velocity, Displacement

This quantities are represented by magnitude as well as direction.

Scalar field & vector field :-

Scalar field :- A field define by Scalar quantity is called Scalar field

vector field :- A field define by vector quantity is called vector field.

Scalar funcn & vector funcn

Scalar funcn = $y = f(x) = x^2 + 2x + 5$

vector funcn = $\vec{F} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$

Gradient of Scalar field

Gradient of a scalar field is represent maximum ~~weight~~ rate of change in scalar funcn. It is a vector quantity.

It represented by (grad ϕ)

If (ϕ) is a scalar function then,

$$\text{grad}\,\phi = \vec{\nabla}.\phi$$

$$\vec{\nabla} = \hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}$$

$$\text{grad}\,\phi = \hat{i}\frac{\partial\phi}{\partial x} + \hat{j}\frac{\partial\phi}{\partial y} + \hat{k}\frac{\partial\phi}{\partial z}$$

Q.1 A Scalar funcn (ϕ) is defined by $x^2+xy+zx$ $\phi = x^2+xy+zx$, then find out the value of gradient of (ϕ) at point (1,1,1)

$\phi = x^2 + xy + zx$

grad ϕ at Point (1,1,1)

$$\text{grad}\,\phi = \hat{i}\frac{\partial\phi}{\partial x} + \hat{j}\frac{\partial\phi}{\partial y} + \hat{k}\frac{\partial\phi}{\partial z}$$

$$\text{grad}\,\phi = \hat{i}[2x+y+z] + \hat{j}[x] + \hat{k}[x]$$

at Point (1,1,1)

$$\text{grad}\,\phi = 4\hat{i} + \hat{j} + \hat{k}$$

$$d\phi = \vec{E}.\vec{ds}$$
$$\phi = \iint \vec{E}.\vec{ds}$$

① gradient or divergence MST-2 numerical

Q.2 A Scalar funcn is defined by $\phi = xy + yz + z^2$. find gradient grad ϕ at Point (1,2,1)

$\phi = xy + yz + z^2$

grad ϕ at Point (1,2,1)

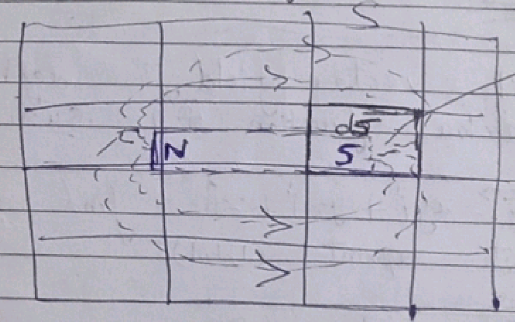
$$\text{grad}\,\phi = \hat{i}\frac{\partial\phi}{\partial x} + \hat{j}\frac{\partial\phi}{\partial y} + \hat{k}\frac{\partial\phi}{\partial z}$$

$$\text{grad}\,\phi = \hat{i}[y] + \hat{j}[x+z] + \hat{k}[y+2z]$$

at Point (1,2,1)

$$\text{grad}\,\phi = 2\hat{i} + 2\hat{j} + 4\hat{k}$$

Magnetic flux



$$d\phi = \vec{B}.\vec{ds}$$
$$\phi = \iint \vec{B}.\vec{ds}$$

→ Magnetic lines of forces Passing normal through the Surfaces is called magnetic flux. Magnetic flux associated with Surface ds is given by

$$d\phi = \vec{B}.\vec{ds}$$

Hence total flux through the Surface (S) is given by

$$\phi = \iint \vec{B}.\vec{ds}$$

$\vec{\cdot}\,\vec{\cdot} =$ Scalar quantity
vec, vector
13/05/25

Divergence of a vector field

divergence of a vector field at a point is defined as the amount of flux per unit volume diverging from that point

It is represented by divergence of $\vec{F}$

$$\text{div}\,\vec{F} = \vec{\nabla}\cdot\vec{F}$$

let $\vec{f} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$

$$\text{div}\,\vec{F} = \left(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}\right)\left(f_x\hat{i} + f_y\hat{j} + f_z\hat{k}\right)$$

$$\text{div}\,\vec{F} = \frac{\partial}{\partial x}f_x + \frac{\partial}{\partial y}f_y + \frac{\partial}{\partial z}f_z$$

Question: A vector field is defined by a vector function $(\vec{F})$ such that

$\vec{F} = xy\hat{i} + yz\hat{j} + z\hat{k}$ find ~~divergence~~ div $\vec{F}$ at point $(1,1,1)$

Soln:

$\vec{F} = xy\hat{i} + yz\hat{j} + z\hat{k}$

general Eqn

$\vec{F} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$

$f_x = xy,\ f_y = yz,\ f_z = z$

Know

formula of $\text{div}\,\vec{f} = \frac{\partial}{\partial x}f_x + \frac{\partial}{\partial y}f_y + \frac{\partial}{\partial z}f_z$

$$\text{div}\,\vec{f} = \frac{\partial}{\partial x}[xy] + \frac{\partial}{\partial y}[yz] + \frac{\partial}{\partial z}[z]$$

1 Acre = 43560 feet

$\text{div}\,\vec{f} = y + z + 1$

at point $(1,1,1)$

$\text{div}\,\vec{f} = 1+1+1$

$$\text{div}\,\vec{f} = 3$$

Q2 A vector field as defined by a vector funcn $(\vec{F})$ such that $\vec{F} = x^2y\hat{i} + y\hat{j} + z^2x\hat{k}$. find div $\vec{f}$ at point $(-1,1,-1)$

Soln

$\vec{F} = x^2y\hat{i} + y\hat{j} + z^2x\hat{k}$

general Eqn

$\vec{f} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$

$\text{div}\,\vec{f} = \frac{\partial}{\partial x}f_x + \frac{\partial}{\partial y}f_y + \frac{\partial}{\partial z}f_z$

$\text{div}\,\vec{f} = 2xy + 1 + 2zx$

at point $(-1,1,-1)$

$\text{div}\,\vec{f} = 2(-1)(1) + 1 + 2(-1)(-1)$

$\text{div}\,\vec{f} = -2+1+2 = 1$

$\int dl \rightarrow$ line Integral

$ds = dx\,dy$

$dv = dx\,dy\,dz$

$\iint ds \rightarrow$ Surface Integral

$\iiint dv \rightarrow$ volume integral

14/05/25

Date: / / Page no:

Curl of a vector field

It is defined as maximum value of line integral per unit area. It is represented by Curl $\vec{F}$ and is is vector quantity

$$\text{Curl } \vec{F} = \vec{\nabla} \times \vec{F}$$

let

$$\vec{F} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$$

$$\text{Curl } \vec{f} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ f_x & f_y & f_z \end{vmatrix} = \hat{i}\left[\frac{\partial}{\partial y} f_z - \frac{\partial}{\partial z} f_y\right] - \hat{j}\left[\frac{\partial}{\partial x} f_z - \frac{\partial}{\partial z} f_x\right] + \hat{k}\left[\frac{\partial}{\partial x} f_y - \frac{\partial}{\partial y} f_x\right]$$

$$\hat{i}\left[\frac{\partial}{\partial y} f_z - \frac{\partial}{\partial z} f_y\right] - \hat{j}\left[\frac{\partial}{\partial x} f_z - \frac{\partial}{\partial z} f_x\right] + \hat{k}\left[\frac{\partial}{\partial x} f_y - \frac{\partial}{\partial y} f_x\right]$$

Date: / / Page no:

MST-II

A vector field f is defined by a funcn such that $\vec{F} = xy\hat{i} + yz\hat{j} + zx\hat{k}$ find the Curl $\vec{F}$ at points (1,2,3)

$$\text{Curl } \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ f_x & f_y & f_z \end{vmatrix}$$

$$\text{Curl } \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & yz & zx \end{vmatrix}$$

$$\text{Curl } \vec{F} = \hat{i}(0 - y) - \hat{j}(z - 0) + \hat{k}(0 - x)$$

at point (1,2,3)

$$\text{Curl } \vec{f} = -2\hat{i} - 3\hat{j} - \hat{k}$$

Ans

S.

1 3,5 15/05/25

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Date: / / Page no:

$d\vec{l} = dx$
$ds = dxdy$
$dv = dxdydz$

MST-II

Gauss divergence theorem :

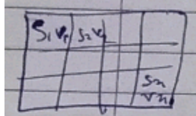
By using this theorem we can convert volume integral to surface integral

flux of a vector function $\vec{F}$ over the closed surface (S) is equal to the volume integration of $\mathrm{div}\vec{F}$ over the volume (v)

$$\iint \vec{F}\cdot\vec{ds} = \iiint \mathrm{div}\,\vec{F}\,dv$$

Proof:
Let a closed surface (s) and enclosed volume (v). We divide the surface (S) into (n) equal parts. Such that surface (s) $s_1, s_2, ---, s_n$ and enclosed volume (v) $v_1, v_2, ---, v_n$ respectively

$S \to V$



→ If ~~vector~~ $\vec{F}$ is define ~~the surface(s)~~
~~then~~

→ If $\vec{F}$ is defined on the surface (S) then flux related with surface (s)

$$\phi = \iint \vec{f}\cdot\vec{ds} \quad \text{—} ①$$

flux related with surface s_1

$$\phi_1 = \iint \vec{f}\cdot\vec{ds_1}$$

flux related with surface s_n

$$\phi_n = \iint \vec{F}\cdot\vec{ds_n}$$

15/05/25

Date: / / Page

ϕ = weber

Total flux

$$\phi = \phi_1 + \phi_2 + --- + \phi_n$$

$$\phi = \iint \vec{F}\cdot\vec{ds_1} + \iint \vec{F}\cdot\vec{ds_2} + --- + \iint \vec{F}\cdot\vec{ds_n}$$

$$\iint \vec{F}\cdot\vec{ds} = \sum_{i=1}^{n} \iint \vec{F}\cdot\vec{ds_i}$$

$$\iint \vec{F}\cdot\vec{ds} = \sum_{i=1}^{n} V_i \left(\frac{\iint \vec{F}\cdot\vec{ds_i}}{V_i}\right)$$

W.K.T

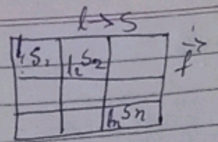
$$\mathrm{div}\vec{F} = \frac{\iint \vec{F}\cdot\vec{ds}}{v}$$

$$\Sigma V_i = V = \iiint dv$$

$$\iint \vec{F}\cdot\vec{ds} = \iiint \mathrm{div}\vec{F}\,dv$$

16/05/25

Stoke's theorem



Surface integral curl $\vec{F}$ of a $\vec{F}$ over the surface(s) is equal to the line integral of that vector over the closed boundary (l)

$$\iint \text{Curl } \vec{F}\cdot\vec{ds} = \oint \vec{F}\cdot\vec{dl}$$

Proof :-

By integrating $\vec{F}$ over the all boundary (l) we get line integral of $\vec{F}$ $(\oint\vec{F})$

If the hole boundary (l) is divided into n equal parts such that length surfaces $l_1, l_2, l_3, \ldots, l_n$ enclosed surfaces $S_1, S_2, \ldots, S_n$ respectively

$$\oint\vec{F}\cdot\vec{dl} = \oint\vec{F}\cdot\vec{dl_1} + \oint\vec{F}\cdot\vec{dl_2} + \ldots + \oint\vec{F}\cdot\vec{dl_n}$$

$$\oint\vec{F}\cdot\vec{dl} = \sum_{i=1}^{n} \oint\vec{F}\cdot\vec{dl_i}$$

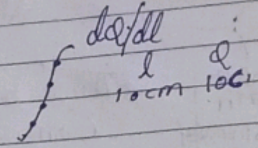
$$\oint\vec{F}\cdot\vec{dl} = \sum S_i\left[\frac{\oint\vec{F}\cdot\vec{dl_i}}{S_i}\right] \quad -(1)$$

By defination Curl $\vec{F} = \dfrac{\oint\vec{F}\cdot\vec{dl}}{S}$

$$\Sigma S_i = S = \iint ds$$

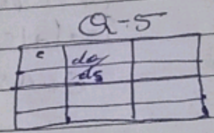
$$\oint\vec{F}\cdot\vec{dl} = \iint \text{curl } \vec{F}\cdot\vec{ds}$$

* Charge distribution :-



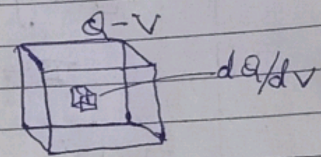
Linear charge density

$$\lambda = \frac{dQ}{dl}$$



Surface charge density

$$\sigma = \frac{dQ}{ds}$$



Volume charge density

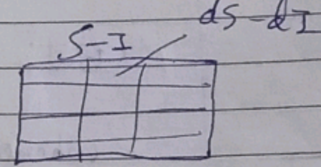
$$\rho = \frac{dQ}{dV}$$

$$dQ = \rho\, dv$$

$$\int dQ = \iiint \rho\, dv$$

$$Q = \iiint \rho\, dv$$

* Current density :-



$$j = \frac{I}{A}$$

If dI current is flowing through the surface (ds) then current density is defined as

$$j = \frac{dI}{ds}$$

$$dI = j\cdot ds$$

$$\int dI = \iint j\cdot ds$$

$$I = \iint \vec{j}\cdot\vec{ds}$$

विद्युत current density धारा

23/05/25 ϵ_0

Equation of Continuity

wake sath volume of charge density time के साथ घट रहा

This Eq^n is ~~best~~ based on law of Conservation of charge according to that total charge in an isolated System is always remain conserved.

By defination

$$I = -\frac{dQ}{dt} \quad -① $$

Total charge flowing through the volume (v) is

$$Q = \iiint \rho \, dv \quad -②$$

where ρ is volume charge density

But $I = \iint \vec{J} \cdot \vec{ds} \quad -③$

where $\vec{J}$ is Current density

from eq^n 1 & 3

$$\iint \vec{J} \vec{ds} = \frac{-dQ}{dt}$$

$$\iint \vec{J} \vec{ds} = \frac{-d}{dt} \iiint \rho \, dv$$

$$\iint \vec{J} \vec{ds} = -\iiint \frac{d\rho}{dt} dv$$

Gauss divergence theorem $\rightarrow \iint \vec{F} \vec{ds} = \iiint \operatorname{div} F . dv$

ρ

By using Gauss divergence theorem

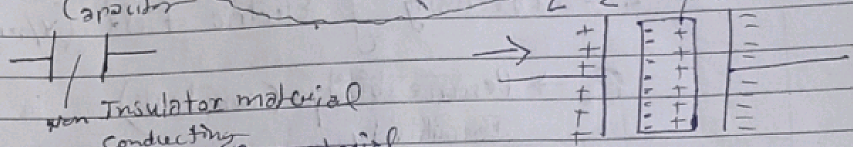
$$\iiint \operatorname{div} \vec{J} \, d\vec{v} = -\iiint \frac{d\rho}{dt} dv$$

$$\operatorname{div} \vec{J} = -\frac{d\rho}{dt}$$

$$\operatorname{div} \vec{J} + \frac{d\rho}{dt} = 0$$

$\vec{E} \leftarrow \vec{D}$ efficiently

Capacitor



Insulator material

conducting

dielectric material

$E = qV$

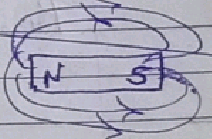
$D = \epsilon_0 E$

where E = Intensity of electric field

$D \rightarrow$ Electric displacement

26/05/25

$\vec{B} = \mu_0 \vec{H}$



magnetic flux per unit area

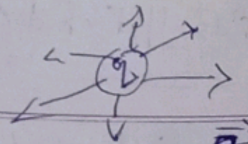
M.f. density

$\vec{B}$ = Magnetic flux density (web/m²)

$\vec{H}$ = Intensity of magnetic field (A/m)

$(\mu_0) \rightarrow$ permeability (constant)

ρ



26/05/25 $N\alpha e^{-E/kT}$ M Boltzman

$\cancel{\vec{B} = \mu_0 \vec{E}}$

$\phi = \iint \vec{E} \cdot d\vec{s} = \frac{Q}{\varepsilon_0}$

$\cancel{\vec{D} = \varepsilon_0 \vec{E}}$ $\vec{D} = \varepsilon_0 \vec{E}$

$\vec{D}$ = Electrical displacement

or Electric flux density (C/m^2)

$\vec{E}$ = Intensity of Electric field (V/m)

$\varepsilon_0 \to$ ~~Permeability~~ Permittivity (constant)

Maxwell Ist Eqn

Differential form $\to \vec{\nabla} \cdot \vec{D} = \rho$;

Integral form $\to \iint \vec{D} \cdot d\vec{s} = \iiint \rho\, dv$

Proof $\to$

According to Gauss law of electric field.

$$\phi = \iint \vec{E} \cdot d\vec{s} = \frac{Q}{\varepsilon_0}$$

$$\iint \varepsilon_0 \vec{E} \cdot d\vec{s} = Q$$

$$\iint \vec{D} \cdot d\vec{s} = Q \quad \text{--- (1)}$$

If ρ is volume charge density

$$Q = \iiint \rho\, dv$$

26/05/25

By Placing value in Eqn (1)

$\iint \vec{D} \cdot d\vec{s} = \iiint \rho\, dv$ Ans Hence proved.

By using Gauss divergence theorem

$$\iiint \operatorname{div} \vec{D}\, dv = \iiint \rho\, dv$$

$$\operatorname{div} \vec{D} = \rho$$

$\vec{\nabla} \cdot \vec{D} = \rho$ Hence proved

27/05/25

Maxwell 2nd Eqn

In differential form $\to \vec{\nabla} \cdot \vec{B} = 0$

In integral form $\to \iint \vec{B} \cdot d\vec{s} = 0$

Proof :- This eqn is based on Gauss law of magnetic field. According to that net magnetic flux passing out from a closed is equal to zero

$$\iint \vec{B} \cdot d\vec{s} = 0$$

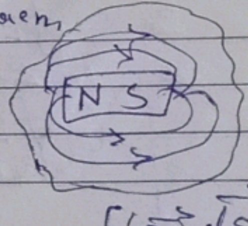
According to Gauss divergence theorem,

$$\iiint \operatorname{div} \vec{B}\, dv = 0$$

for finite volume

$$\operatorname{div} \vec{B} = 0$$

$$\vec{\nabla} \cdot \vec{B} = 0$$



$\iint \vec{B} \cdot d\vec{s}$

Assignment 2nd change in $\vec{E}$ rel^n b/w $\vec{B}$

27/05/25

Date: / / Page no:

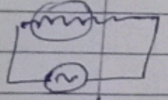
Faraday's law

Maxwell's 3rd Eqn

In differential form → $\vec{\nabla} \times \vec{E} = \frac{-d\vec{B}}{dt}$

In integral form → $\oint \vec{E} \cdot \vec{dl} = -\iint \frac{d\vec{B}}{dt} \vec{ds}$

This Eqn is based on faraday's law and according to this law whenever there is a change in magnetic flux linked with a coil then an e.m.f. is induced in it and it always opposes the cause which produce it



$e = \frac{-d\phi}{dt}$

Proof → $e = \frac{-d\phi}{dt}$ ①

By defination

$e = \oint \vec{E} \cdot \vec{dl}$ ②

By comparing eqn ① & ②

$\oint \vec{E} \cdot \vec{dl} = \frac{-d\phi}{dt}$

But $\phi = \iint \vec{B} \cdot \vec{ds}$

$\oint \vec{E} \cdot \vec{dl} = \frac{-d}{dt} \iint \vec{B} \cdot \vec{ds}$

$\oint \vec{E} \cdot \vec{dl} = -\iint \frac{d\vec{B}}{dt} \vec{ds}$

By Applying stoke's theorem

$\iint \text{curl} \vec{E} \, \vec{ds} = -\iint \frac{d\vec{B}}{dt} \vec{ds}$

$\text{curl} \vec{E} = -\frac{d\vec{B}}{dt}$

By defination of curl

$\vec{\nabla} \times \vec{E} = \frac{-d\vec{B}}{dt}$

Assignment → ③ state & proof Eq^n of continuity
④ write Maxwell's 4th eqn & gives its proof
⑤ state & proof stoke's theorem.

12/06/25

I_c conduct^n → current
I_d displacement

Maxwell's 4th Eqn

In differential form → $\vec{\nabla} \times \vec{H} = \vec{J_c} + \frac{d\vec{D}}{dt}$

In Integral form → $\oint \vec{H} \cdot \vec{dl} = \iint \left[\vec{J_c} + \frac{d\vec{D}}{dt} \right] \vec{ds}$

Proof →

According to Ampere's law

$\oint_C \vec{B} \cdot \vec{dl} = \mu_0 I = \mu_0 [I_c + I_d]$

$\oint_C \vec{B} \cdot \vec{dl} = \mu_0 \left[\iint I_c \cdot ds + \iint_S \vec{J_d} \cdot \vec{ds} \right]$

$\oint_C \vec{B} \cdot \vec{dl} = \mu_0 \left[\iint_S \vec{J_c} \vec{ds} + \iint_S \frac{\partial \vec{D}}{\partial t} \vec{ds} \right]$

$\vec{B} = \mu_0 \vec{H}$

$\oint_C \vec{B} \cdot \vec{dl} = \mu_0 \iint_S \left[\vec{J_c} + \frac{\partial \vec{D}}{dt} \right] \vec{ds}$

$\vec{J_d} = \frac{\partial \vec{D}}{\partial t}$

$\cancel{\mu_0} \oint \vec{H} \cdot \vec{dl} = \cancel{\mu_0} \iint_S \left[\vec{J_c} + \frac{\partial \vec{D}}{dt} \right] ds$ Integral form

By applying Stoke's theorem

$\iint_S \text{curl} \vec{H} \cdot \vec{ds} = \iint_S \left[J_c + \frac{\partial \vec{D}}{dt} \right] \vec{ds}$

$\text{Curl} \vec{H} = J_c + \frac{\partial \vec{D}}{dt}$

$\vec{\nabla} \times \vec{H} = J_c + \frac{\partial \vec{D}}{dt}$

Differential form

laser vapour default ptd

28/05/25

Date: / / Page no:

UNIT-III Introduction to solid

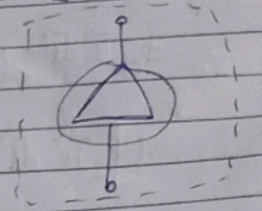
Q1 Explain junction diode and its V-I characteristics

→

* A P-N junction diode

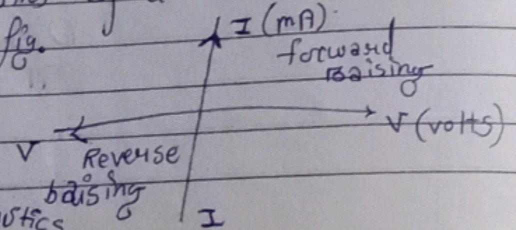
* A P-N junction is formed by combining A P-type and N-type semiconductor material where P-type is having accepter impurities and N-type is having donner impurities

* Symbol → A P-N-Junction diode is represented as



* the P-N Junction is a controlled element for semiconductor devices. A P-N simple P-N junction behaves like a two terminal semiconductor device known as Diode

* V-I characterstics of an ideal diode is shown in fig.



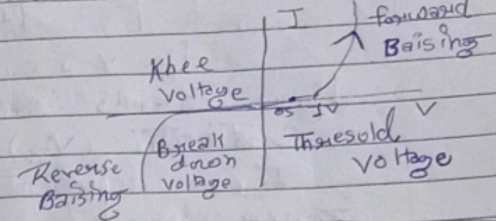
Ideal diode V-I characteristics

28/05/25

Date: / / Page no:

* An Ideal diode acts like a switch when the diode is forward Baised it behaves like a closed switch

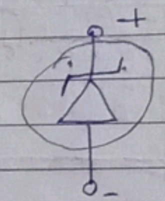
Real diode V-I characteristics



Zener diode

* Zt is also a P-N Junction diode But it is specifically design to work in reversed baised condition

* It is represented by the symbol



* when the zener diode is operated in the break down region it mentains a constant voltage across the terminals

* Zener diode is also reffered as constant voltage diode

30/05/25

I_{zm} = max^m rated Current

V-I Characteristic of zener diode

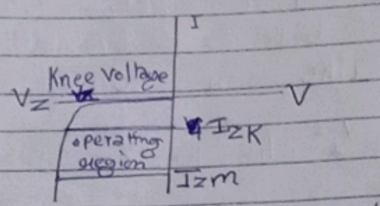


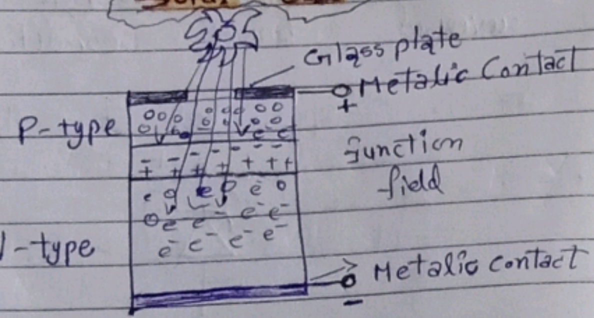
fig. V-I characteristic of zener diode

figure shows that the voltage is almost constant (V_Z) over the operating region. I_{zm} represent max^m rated zener current. Zener breakdown occurs in heavily dopped junction where as avalanche breakdown occurs in lightly dopped junction

30/05/25

③

Solar Cell



- It is a device that converts solar energy into electrical energy
- Mostly solar cells are made by semiconductor materials like silicon

drift velocity

$j = -NqV$

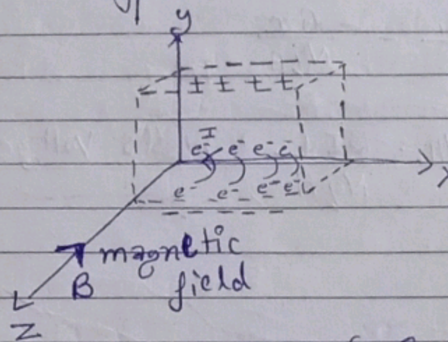
N-fq carrier

30/05/25

- When light is incident on the PN-junction diode of a solar cell then it creates electron and holes pairs.
- Junction field sweeps out electrons into N region and holes into P region. It creates the potential difference b/w the two sides of the electrode. This is called photo e.m.f.

Hall's Effect :-

When a metal or semiconductor carrying current I is placed in a transverse magnetic field then a potential difference is produced perpendicular to the direction of current and magnetic field. This effect is called Hall's effect.



~~Lorrange~~ force

Lorentz

$BqV \sin\theta$

$\theta = 90$

BqV

03/06/25 Electric field ($E = \frac{V}{d}$) voltage

Lorentz force is given by

$f = BqV$ — (1)

force due to electric field

$F = qE_H$ — (2)

from Eqn (1) & (2)

$BqV = qE_H$

$V = E_H / B$ — (2)

$J = \frac{I}{A}$

$J = -NqV$

$E = \frac{V}{d}$

Current density

$J = -NqV$

$\frac{I}{A} = \frac{-Nq E_H}{B}$

$E_H = \frac{-BI}{NqA}$ - Hall's Electric field

E

$\frac{V_H}{d} = \frac{-BI}{NqA}$

$\{ \because E = \frac{V}{d} \}$

$V_H = \frac{-BId}{NqA}$ Hall's Voltage

04/06/25

$Si = 4 \quad \begin{matrix} s & p \\ 2 & 2 \\ 2 & 6 \end{matrix}$

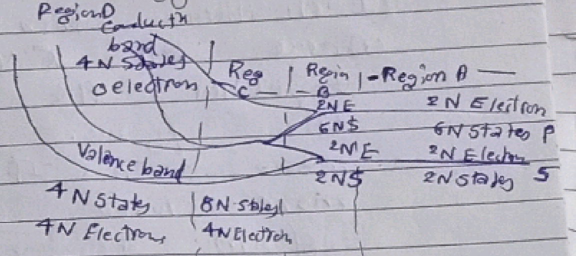
~~energy~~

Origin of Energy Bands :-

$Si \to 4 \to s \; p$

$\frac{2}{2} \; \frac{2}{6}$

$N \to 4N \to \frac{2N}{2N} \; \frac{2N}{6N}$



Assumed spacing

We assume that the Silicon cristal contains N atoms the number of electrons in the outermost orbit is (4) [$2s^2 2p^2$] electrons ~~hence the~~ ~~to the~~ total no. of outer ~~most~~ electron in the cristal 4N. The Max^m possible No. of outer electrons in the orbit is 8 so out of 4N Electrons & 2N Electrons are in the 2N s states and 2N electrons are in 6N p states

when this atoms are coming closer to each other to form a solid the energy of this electrons in the outer most orbit may change due to the interaction b/w the electrons.

The 6N states spreadout and form an energy band. It is shown as region B in the diagram

05/06/25

If this atoms are coming more closer to each other then region c are formed where all 8N states are mixed together this region is shown in the figure. If this atoms are coming more closer to each other to form a cristaline solid then region D is formed. where 8N states splite up equally and form valance & conduction band 4N electrons are present in valance band and conduction band is empty.

Q.1 Explain Solids on the basis of Energy band theory

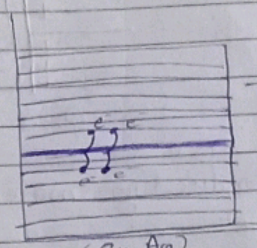
Soln

On the basis of conductivity and Energy band theory Solids are classified into three categories

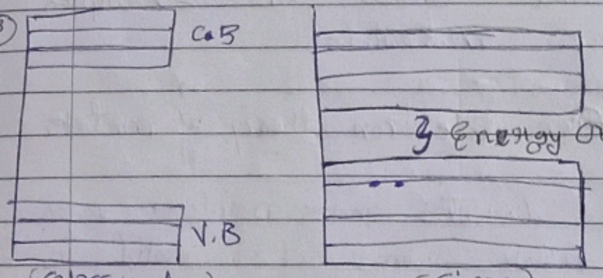
1. Conductor
2. Semiconductor
3. Insulator

(1) Conductor:- In Conductors valance band is in contact with conduction band. So Electron can easily move from valance band to conduction. they offers low resistance in the flow of current. On increasing the temperature their conductivity decreases. Cu, Ag are good conductors.

Super conductor



(2) Semiconductors:- In semiconductor an energy gap is present (Eg) between valance band and conduction band. On increasing the temperature conductivity of semiconductor is increases. (Si, Ge) are examples of pure semiconductor material

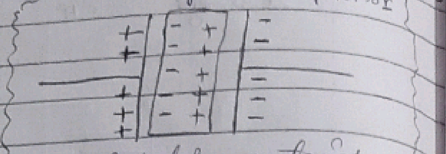


(3) Insulator:- A wide energy gap exist between valance band and conduction band they offers high resistance for current. (Glass, wood) are examples of Insulating material.

micasheet 06/JUN/25

Dielectric

Write short notes on ~~dielectric~~ dielectric → Dielectric material (capacitor)



Dielectric material

① They are non-conducting materials

② when this materials are placed in electric or magnetic field they get polarized

③ Due to ~~palizat~~ polarization property this materials are used in energy storing devices.

④ Micasheet and Glass are Examples of Dielectric materials

Lorentz & Drude Free Electron theory of metals

→ According to Lorentz and Drude 95% of the whole volume of a Solid is occupied by electrons and only 5% by others

→ Hence According to Free electron theory the Solid behaves like ~~as~~ of a free electron gas

06/JUN/25 $\bar{c} = \sqrt{\frac{3K_BT}{m}}$

K_B = Boltzman Constant

m = mass

→ The large electrical and thermal conductivity of metals can be explained by the presents of free electron (conduction electrons) in the metals.

→ At lowest possible temperature all electrons occupy ~~endo~~ lower energy level

→ Root mean Square velocity of electron is given by

$$\bar{c} = \sqrt{\frac{3K_BT}{m}}$$

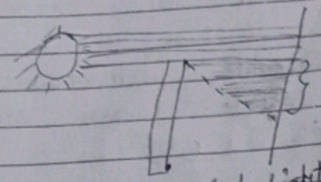
where K_B = Boltzman Constant & m is mass

10/06/25

Wave optics :

Diffraction :

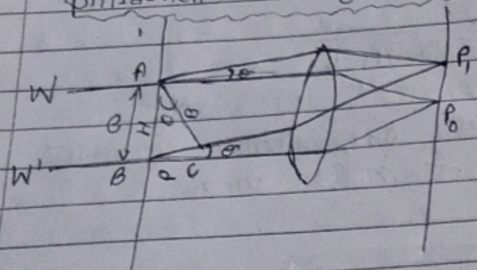
It is the property of light that it bends towards the ~~corner~~ corner this is known as diffraction



Geometrical shadow area

Enchrochment of light into geometrical shadow area

Diffraction at single slit } & give cond^n for max^m & min^m intensity



P_0 = max^m intensity

centre

position

→ let AB is a slit of width e. W, W' is a wavefront incident on the slit AB

→ Waves of those are moving ⊥ to the slit are focused at point (P_0) and wave those are moving at angle θ are focused at point P_1

Path difference = BC

$$\sin\theta = \frac{BC}{AB} = \frac{BC}{e}$$

$$BC = e\sin\theta$$

10/06/25

for vector Addition $R = a\,\dfrac{\sin\frac{n\alpha}{2}}{\sin\frac{\alpha}{2}}$

Path difference = $BC = e\sin\theta$

Phase difference = $\frac{2\pi}{\lambda} \times$ Path difference

Phase difference = $\frac{2\pi}{\lambda} \times e\sin\theta$

If n waves are passing through the slit AB of Amplitude (a) then phase difference b/w two continuous wave is equal to $\frac{1}{n} \times \left(\frac{2\pi}{\lambda} \times e\sin\theta\right)$

$$= \frac{1}{n} \times \left(\frac{2\pi}{\lambda} \times e\sin\theta\right) = \alpha$$

$$R = a\,\frac{\sin\frac{n\alpha}{2}}{\sin\alpha/2}$$

$$R = a\,\frac{\sin\frac{\pi}{\lambda}e\sin\theta}{\sin\frac{\pi e\sin\theta}{n\lambda}}$$

let $\frac{\pi e\sin\theta}{\lambda} = \alpha$

$$R = a\,\frac{\sin\alpha}{\sin\alpha/n}$$

for small angles

$\sin\theta \approx \theta$ {∵ $\sin\theta = \theta$}

$$\sin\alpha/n \approx \frac{\alpha}{n}$$

$$R = a\,\frac{\sin\alpha}{\alpha/n}$$

$$R = an\,\frac{\sin\alpha}{\alpha} \Rightarrow R = \frac{A\sin\alpha}{\alpha}$$

$$I \propto R^2$$

5890 Å
5896 Å
light ~~ambu~~

$R = \frac{A \sin\alpha}{\alpha}$

11/06/25

$I \propto R^2$

where $\alpha = \frac{\pi e \sin\theta}{\lambda}$

Solution

→ Condition for max^m intensity

$\alpha = 0$

$\frac{\pi e \sin\theta}{\lambda} = 0 \Rightarrow \sin\theta = 0 \Rightarrow \theta = 0$

→ Condition for minimum intensity

$\sin\alpha = 0$ but $\alpha \neq 0$

$\sin\alpha = \sin m\pi$

where, $m = \pm1, \pm2, \pm3, \pm4, \ldots$

$\alpha = \pm m\pi$

$\frac{\pi e \sin\theta}{\lambda} = \pm m\pi$

$e \sin\theta = \pm m\lambda$

→ Resolving Power ~~of gratting~~

Ability of an optical instrument to resolve to close object is called resolving Power

15INCH
15000 slit

→ Resolving Power of gratting

Ability of gratting to make Separate pattern of two closed wavelength is called resolving Power of gratting.

It is represented by

$R = \frac{\lambda}{d\lambda}$

λ = Average wavelength
$d\lambda$ = difference of the wavelength

Sodium light
two wavelength
5890 Å
5896 Å

11/06/25

Rayleigh Criterion

According to Rayleigh Criterion two closed wavelengths are seprable If the principle maxima of first wave lies over the first minima of other wave