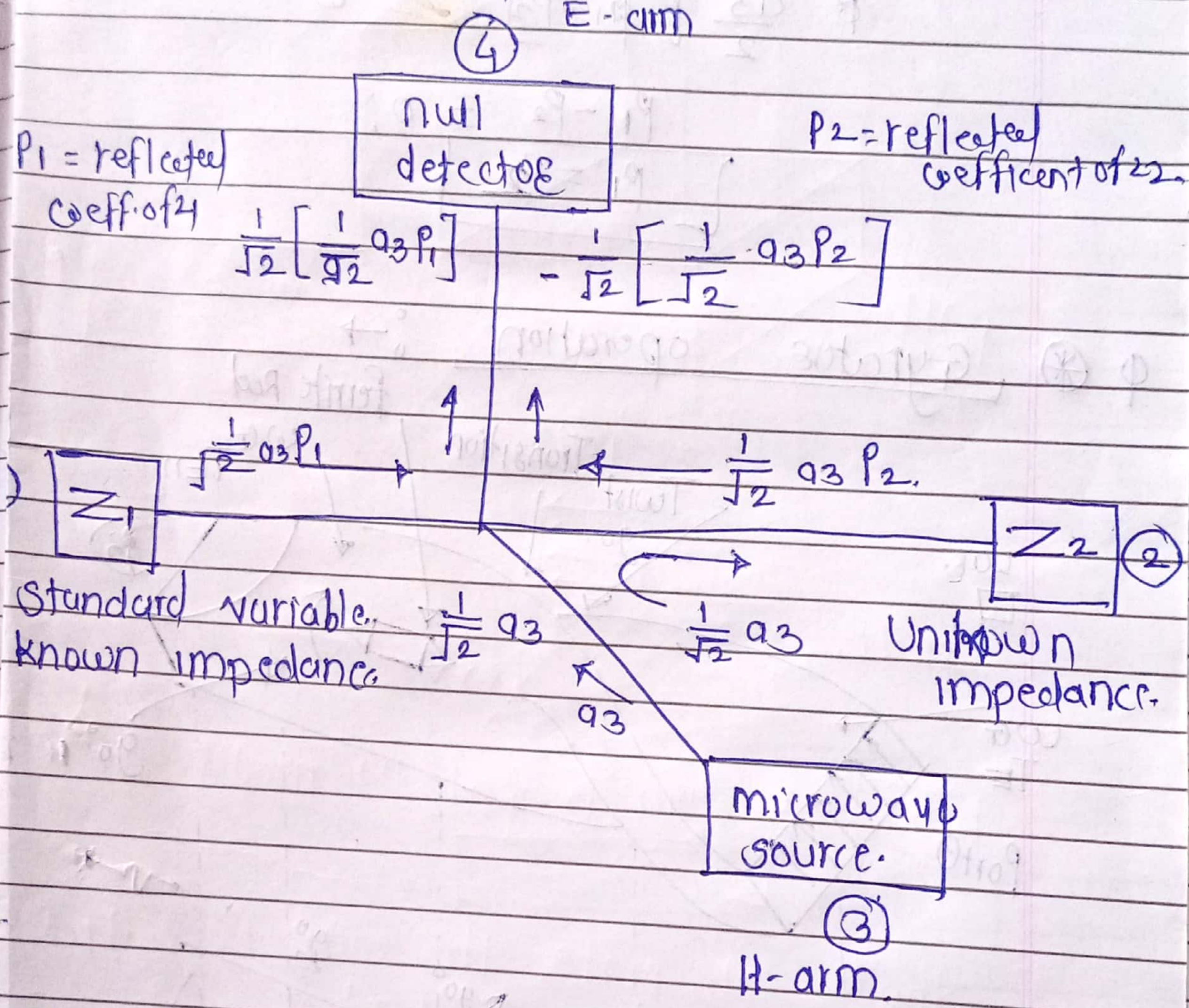
Unit-3, Passive microwave component

(m) With the help of suitable diagram explain the How magic Tee is used for measurment of unknown impedence.



- A magic tree is connected to the form of Bridge. for measuring unknown impedance show in fig.
- null detector is reached the value.

$$= \frac{1}{\sqrt{2}}\left[\frac{1}{\sqrt{2}} a_3 P_1\right] - \frac{1}{\sqrt{2}}\left[\frac{1}{\sqrt{2}} a_3 P_2\right]$$

$$= \frac{a_3}{2}\left[P_1 - P_2\right] \quad \text{——— A}$$

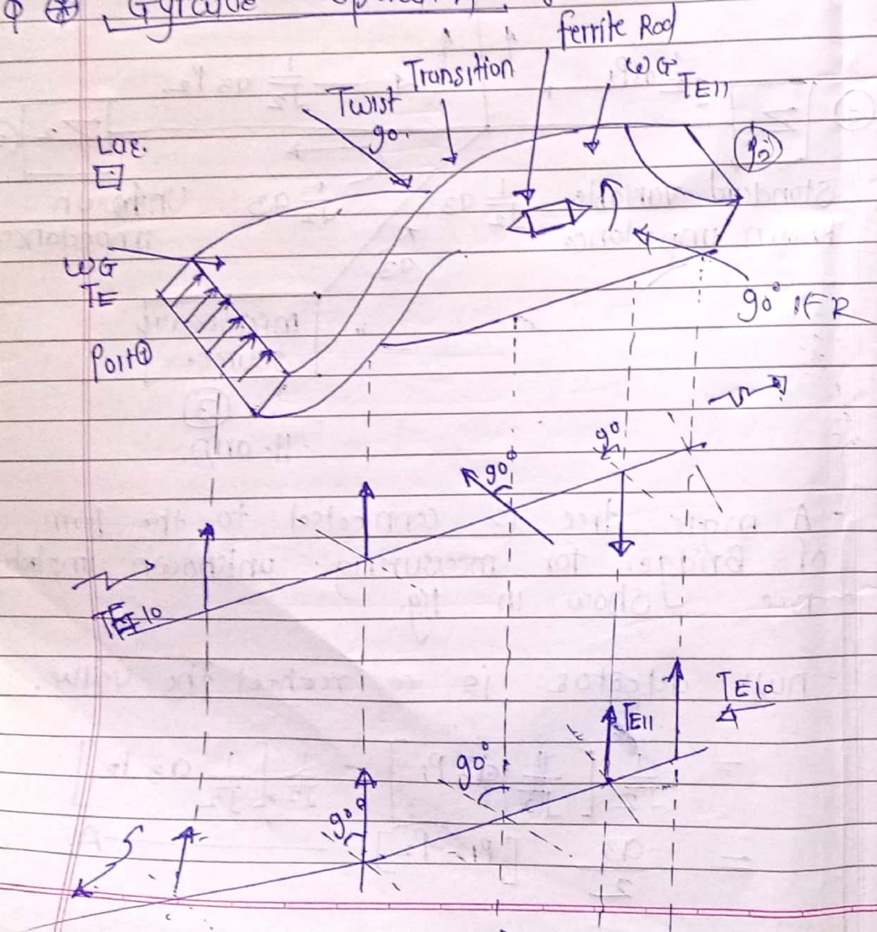
perfect balancing of bridge. that two equat with zero or equal.

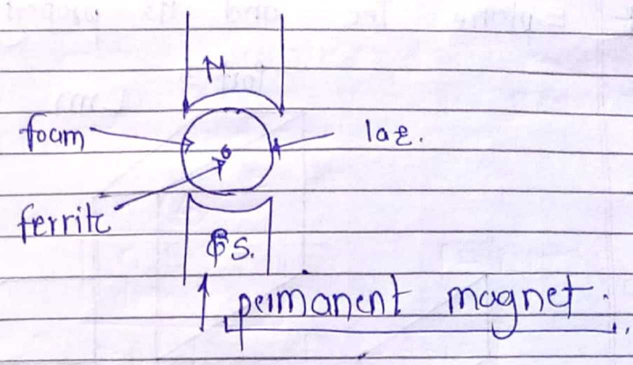
$$\beta \frac{a_3}{2}[P_1 - P_2] = 0$$

$$P_1 - P_2 = 0;$$

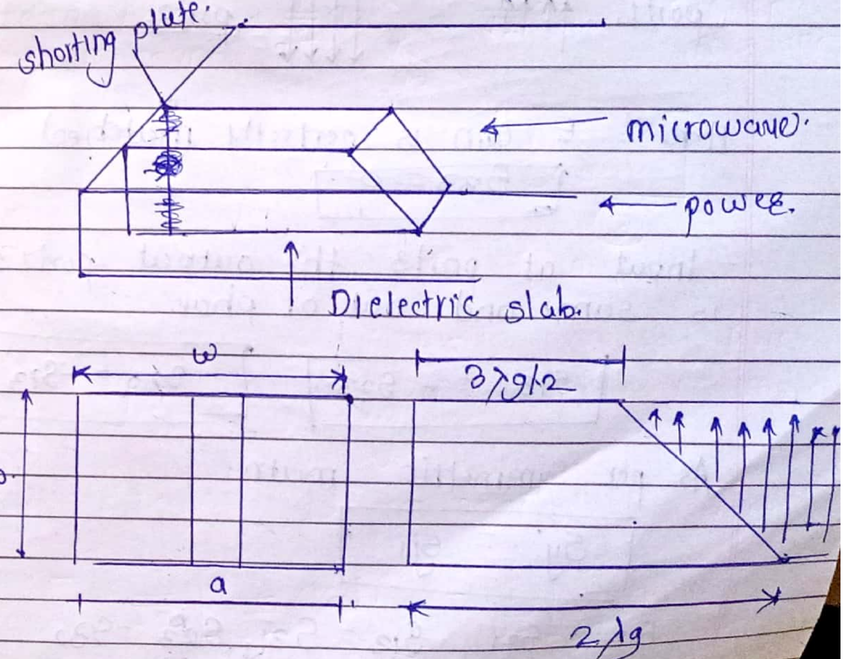
$$\boxed{P_1 = P_2}$$

* Gyrator operation



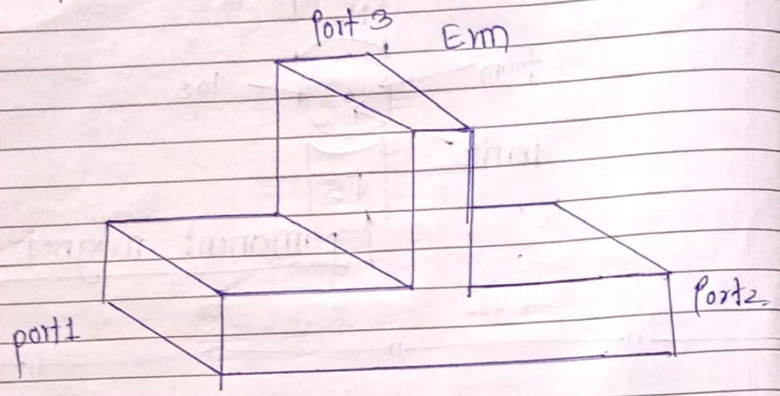


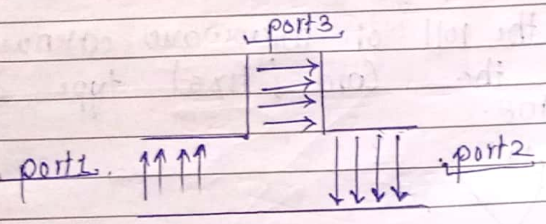
* Explain the roll of microwave attenuator. Explain the Card / fixed type of attenuator.



(b) $a_1 = a_2 = a$ $a_3 = 0$ (c) $a_1 \neq 0,\ a_3 =$
(a) $a_1 = a_2 = 0,\ a_3 \neq 0$

* E plane Tee and its property.





Here E arm is perfectly matched

$\boxed{S_{33} = 0}$

- Input at port 3, the output port 1 & port 2 is same and out of phase.

$\boxed{S_{13} = -S_{23}}$ $\boxed{S_{23} = -S_{13}}$

As per symmetric matrix.

$\boxed{S_{ij} = S_{ji}}$

$S_{12} = S_{21},\ S_{13} = S_{31},\ S_{23} = S_{32}$

$$[S] = \begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{22} & S_{23} \\ S_{31} & S_{32} & S_{33} \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{12} & S_{22} & -S_{13} \\ S_{13} & -S_{13} & 0 \end{bmatrix}$$

- lets unitary property

$$[S][S^*] = I$$

$$\begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{12} & S_{22} & -S_{13} \\ S_{13} & -S_{13} & 0 \end{bmatrix} * \begin{bmatrix} S_{11}^* & S_{12}^* & S_{13}^* \\ S_{12}^* & S_{22}^* & -S_{13}^* \\ S_{13}^* & -S_{13}^* & 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$\Rightarrow R_1C_1 = S_{11}^2 + S_{12}^2 + S_{13}^2 = 1$

$R_2C_2 = S_{12}^2 + S_{22}^2 + S_{13}^2 = 1$

$R_3C_3 = S_{13}^2 + S_{13}^2 = 1$ $\boxed{S_{13} = \frac{1}{\sqrt{2}}}$

$S_{11} = \frac{1}{2},\ S_{22} = \frac{1}{2}.$

$\boxed{S_{11} = S_{22}}$

$R_3C_1 = S_{13}S_{11} + (-S_{13})S_{12} = 0$

$\boxed{S_{11} = S_{12}}$

$\boxed{\therefore S_{11} = S_{12} = S_{22}}$

$R_1C_1 = |S_{12}|^2 + |S_{12}|^2 + \left|\frac{1}{\sqrt{2}}\right|^2 = 1$

$$\begin{bmatrix} \frac{1}{2} & \frac{1}{2} & \frac{1}{\sqrt{2}} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \end{bmatrix}$$

$\therefore [b] = [S][a]$

$$\begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & \frac{1}{\sqrt2} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{\sqrt2} \\ \frac{1}{\sqrt2} & -\frac{1}{\sqrt2} & 0 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}$$

$b_1 = \frac{1}{2}a_1 + \frac{1}{\sqrt2}a_2 + \frac{1}{\sqrt2}a_3$

$b_2 = \frac{1}{2}a_1 + \frac{1}{2}a_2 - \frac{1}{\sqrt2}a_3$

$b_3 = \frac{1}{\sqrt2}a_1 - \frac{1}{\sqrt2}a_2$

(a) $a_1 = a_2 = 0, \quad a_3 \neq 0$

$\boxed{b_1 = \frac{1}{\sqrt2}a_3}$

$b_2 = \frac{-1}{\sqrt2}a_3.$

$b_3 = 0$

(b) $a_1 = a_2 = a, \quad a_3 = 0$

$b_1 = \frac{a}{2} + \frac{a}{2}$

$b_2 = \frac{a}{2} + \frac{a}{2}$

$b_3 = \cancel{\frac{a}{\sqrt2}} - \cancel{\frac{a}{\sqrt2}} = 0$

(c) $a_1 \neq 0 \quad a_2 = 0, \quad a_3 = 0.$

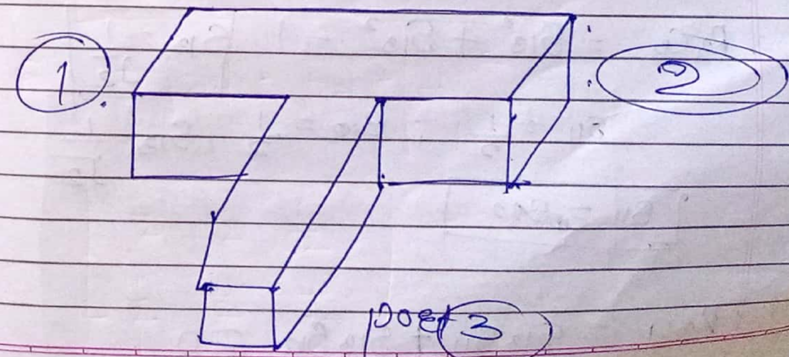
$b_1 = \frac{a_1}{2}, \quad b_2 = \frac{1}{2}a_1, \quad b_3 = \frac{1}{\sqrt2}a_1$

Similarly, we have all combination of i/p and o/p.

Note – E

1. $\boxed{S_{13} = -S_{23}}$
2. $\boxed{S_{33} = 0}$
3. $\boxed{S_{ij} = S_{ji}}$ symmetric property
   $S_{12} = S_{21}, \quad S_{13} = S_{31}, \quad S_{23} = S_{32}$
4. Unitary prop.
   $[S][S^*] = I. \quad \boxed{R3C1}$
5. $[b] = [S][a]$
   (a) $a_1 = a_2 = 0, \quad a_3 \neq 0$
   (b) $a_1 = a_2 = a, \quad a_3 = 0$
   (c) $a_1 \neq 0, \quad a_2 = a_3 = 0$

H plane Tee and properties:→



① $\boxed{S_{13} = S_{23}}$

② $\boxed{S_{33} = 0}$

③ Symmetric property.

$\boxed{S_{ij} = S_{ji}}$

$S_{12} = S_{21}$, $S_{13} = S_{31}$, $S_{23} = S_{32}$

$$[S] = \begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{23} & S_{23} \\ S_{31} & S_{32} & S_{33} \end{bmatrix} \begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{12} & S_{22} & S_{13} \\ S_{13} & S_{13} & 0 \end{bmatrix}$$

④ Unitary property: $[S][S^*] = I$

$$\begin{bmatrix} S_{11}^* & S_{12}^* & S_{13}^* \\ S_{12}^* & S_{22}^* & S_{13}^* \\ S_{13}^* & S_{13}^* & 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$R_1C_1 = |S_{11}|^2 + S_{12}^2 + S_{13}^2 = 1$

$R_2C_2 = |S_{12}|^2 + S_{22}^2 + S_{13}^2 = 1$

$R_3C_3 = S_{13}^2 + S_{13}^2 = 1$ $\boxed{S_{13} = \frac{1}{\sqrt{2}}}$

$S_{11} = \frac{1}{2}$, $S_{12} = \frac{1}{2}$, $S_{13} = \frac{1}{\sqrt{2}}$

$\boxed{S_{11} = S_{22}}$

$R_3C_1 = S_{13}S_{11} + S_{13}S_{12} = 0$

$\boxed{S_{11} = -S_{12}}$

$S_{11} = S_{22} = -S_{12}$

$$\begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} \frac{1}{2} & -\frac{1}{2} & \frac{1}{\sqrt{2}} \\ -\frac{1}{2} & \frac{1}{2} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}$$

$b_1 = \frac{1}{2}a_1 - \frac{1}{2}a_2 + \frac{1}{\sqrt{2}}a_3$

$b_2 = -\frac{1}{2}a_1 + \frac{1}{2}a_2 + \frac{1}{\sqrt{2}}a_3$.

$b_3 = \frac{1}{\sqrt{2}}a_1 + \frac{1}{\sqrt{2}}a_2$

ⓐ $a_1 = a_2 = 0$, $a \neq 0$

$\boxed{b_1 = \frac{1}{\sqrt{2}}a_3}$, $b_3 = 0$

$b_2 = \frac{1}{\sqrt{2}}a_3$

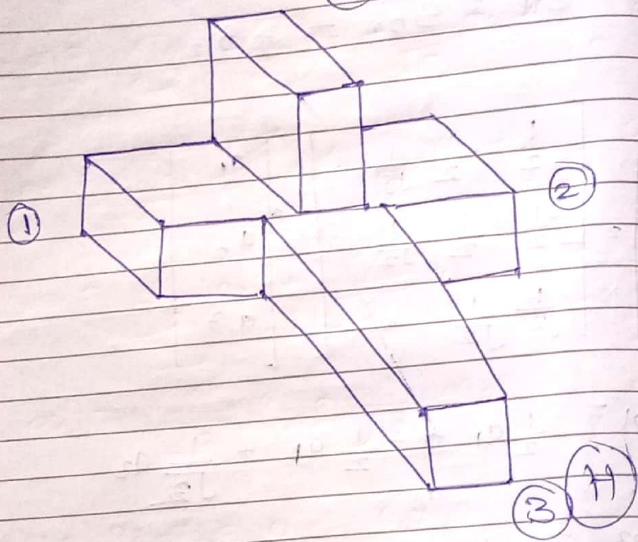
ⓑ $= a_1 = a_2 = a$, $a_3 = 0$

$b_1 = \frac{a}{2} - \frac{a}{2}$ $\boxed{b_1 = 0}$ $b_2 = 0$,

$\boxed{b_3 = \frac{a}{\sqrt{2}} + \frac{a}{\sqrt{2}}}$

ⓒ $a \neq 0$, $a_2 = a_3 = 0$

4. E



① $H = S_{13} = S_{23}$, $S_{33} = 0$

② $E = S_{14} = -S_{24}$, $S_{24} = -S_{14}$

$S_{44} = 0$

$S_{34} = S_{43} = 0$

③ Symmetric. $\boxed{S_{ij} = S_{ji}}$

S

$$S = \begin{bmatrix} S_{11} & S_{12} & S_{13} & S_{14} \\ S_{21} & S_{22} & S_{23} & S_{24} \\ S_{31} & S_{32} & S_{33} & S_{34} \\ S_{41} & S_{42} & S_{43} & S_{44} \end{bmatrix}.$$

$S_{11}^2 = \phi$ $\quad S_{11} = \frac{1}{2}$

$S_{12}^2 = \phi$ $\quad S_{12} = \frac{1}{2}$

$S_{11} = S_{12} = \frac{1}{2}$.

$S_{12} = S_{21}$, $S_{13} = S_{31}$, $S_{14} = S_{41}$,

$S_{23} = S_{32}$, $S_{24} = S_{42}$

→ Unitary property $[S][S^*] = I$.

$$\begin{bmatrix} S_{11} & S_{12} & S_{13} & S_{14} \\ S_{12} & S_{22} & S_{13} & -S_{14} \\ S_{13} & S_{13} & 0 & 0 \\ S_{14} & -S_{14} & 0 & 0 \end{bmatrix} \begin{bmatrix} S_{11}^* & S_{12}^* & S_{13}^* & S_{14}^* \\ S_{12}^* & S_{22}^* & S_{13}^* & -S_{14}^* \\ S_{13}^* & S_{13}^* & 0 & 0 \\ S_{14}^* & -S_{14}^* & 0 & 0 \end{bmatrix}$$

$R_1C_1 = S_{11}^2 + S_{12}^2 + S_{13}^2 + S_{14}^2 = 1$

$R_2C_2 = S_{12}^2 + S_{22}^2 + S_{13}^2 + S_{14}^2 = 1$

$R_3C_3 = S_{13} = \frac{1}{\sqrt{2}}$

$R_4C_4 = S_{14} = \frac{1}{\sqrt{2}}$

$S_{13} = S_{14} = \frac{1}{\sqrt{2}}$, $S_{11} = \frac{1}{2}$, $S_{22} = \frac{1}{2}$,

$R_4C_1 = S_{14}S_{11} + (-S_{14}S_{12})$ $\quad \boxed{S_{11} = S_{12}}$

$S_{13} = \frac{1}{\sqrt{2}}$, $S_{14} = \frac{1}{\sqrt{2}}$, $S_{11} = \frac{1}{2}$, $S_{12} = \frac{1}{2}$.

$S_{22} = \frac{1}{2}$.

$$\begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix} = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 & 0 \\ \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 & 0 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix}$$

Scanned with CamScanner

$a_4 = a = 3, \quad a_4 =$

$a_3 = a_4 =$

$a_1 = a_2 =$

$$b_1 = \frac{1}{2}a_1 + \frac{1}{2}a_2 + \frac{1}{\sqrt{2}}a_3 + \frac{1}{\sqrt{2}}a_4$$

$$b_2 = \frac{1}{2}a_1 + \frac{1}{2}a_2 + \frac{1}{\sqrt{2}}a_3 - \frac{1}{\sqrt{2}}a_4$$

$$b_3 = \frac{1}{\sqrt{2}}a_1 + \frac{1}{\sqrt{2}}a_2 \qquad b_3 = 0$$

$$b_4 = \frac{1}{\sqrt{2}}a_1 - \frac{1}{\sqrt{2}}a_2 \qquad b_4 = 0$$

(a) $a_1 = a_2 = a_3 = 0, \quad a_4 \neq 0,$

$b_1 = \frac{1}{\sqrt{2}}a_4, \quad b_2 = -\frac{1}{\sqrt{2}}, \quad b_3 = b_4 = 0,$

(b) $a_1 = a_2 = a_4 = 0, \quad a \neq 0.$

$b_1 = \frac{1}{\sqrt{2}}a_3, \quad b_2 = \frac{1}{\sqrt{2}}, \quad b_3 = b_4 = 0$

(c) $a_1 \neq 0, \quad a_2 = a_3 = a_4 = 0.$

$b_1 = \frac{1}{2}a, \quad b_2 = \frac{1}{2}a, \quad b_3 = \frac{a_1}{\sqrt{2}}, \quad b_4 = \frac{1}{\sqrt{2}}$

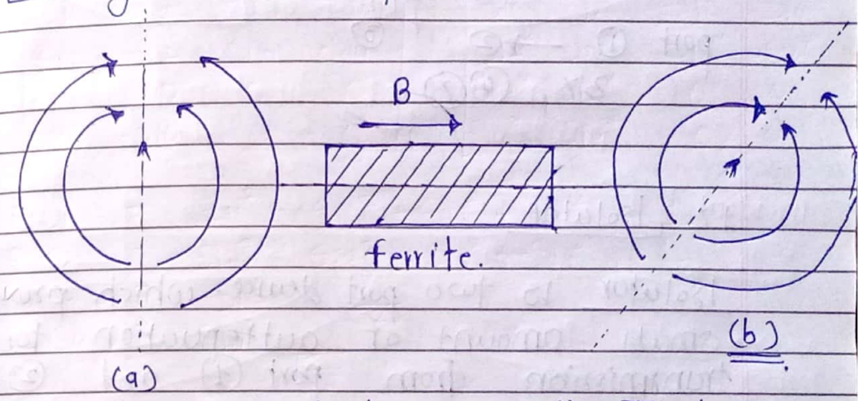
(d) $a_3 = a_4, \quad a_1 = a_2 = 0.$

$b_1 = \frac{1}{\sqrt{2}}(2a_3)$

(e) $a_1 = a_2 \quad a_3 = a_4 = 0.$

$b_1 = 0, \quad b_2 = 0, \quad b_3 = \frac{1}{\sqrt{2}}(2a_2) \quad b_4 = 0$

* Faraday's Rotation principle:→



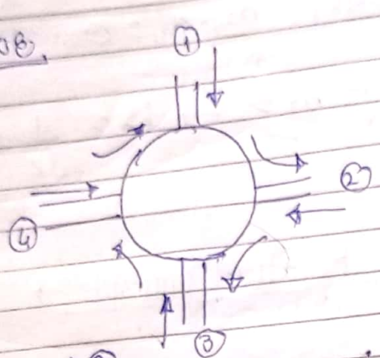
(a) Circularly polarized wave

(b) Tilted pt. polarized wave

fig. a 3.20 illustration of Faraday's rotation principle.

1) Faradays Rotation principle state that circularly polarized wave (TE_{11}) in a cylindrical waveguide made to pass through the ferrite rod. this circular polarized wave pass through B magnetic field through ferrite Rod and get tilted in clockwise direction and the amount of tilted is dependent upon the strength of magnetic field and geometry ferrite Rod shown in fig

Circulator.



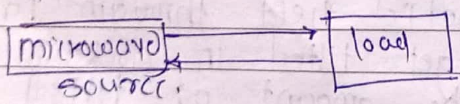
port ① → ②
3X, ④ ③

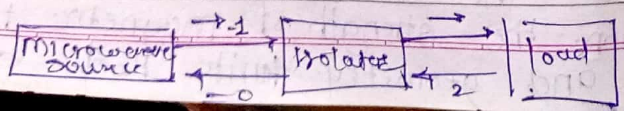
1) Isolator :

Isolator is two port device which provide small amount of auttenuation for transmission from port ① and ②.

- But High amount of auttenuation for transmission from port ② to port ①.

- Suppose the impedent ~~two~~ port are not match time. transmission reflected from port ② to port ① with maximum amount of auttenuation but isolator isolate the this EM wave from port to port ①.





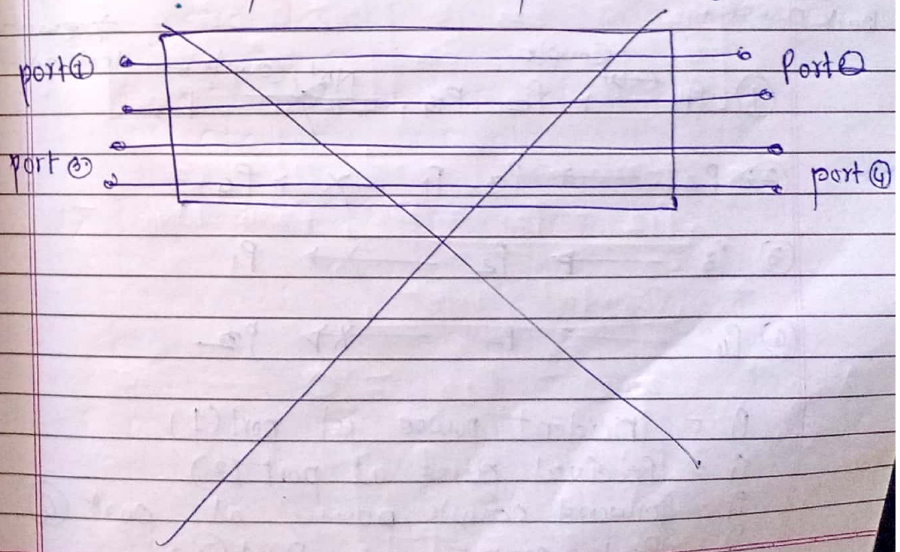
* Directional couplers :→

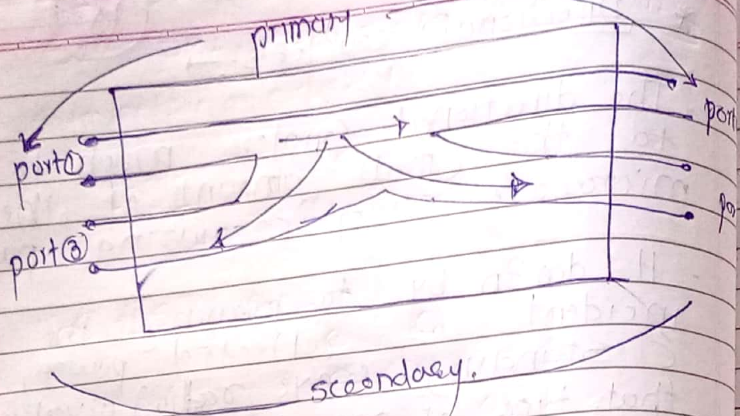
- The directional couplers much be used to the small amount of the microwave power measuring purpose.

- It design by to measured the the incident or reflected power, SWR (standing wave ratio) value. that type of operation perform in which.

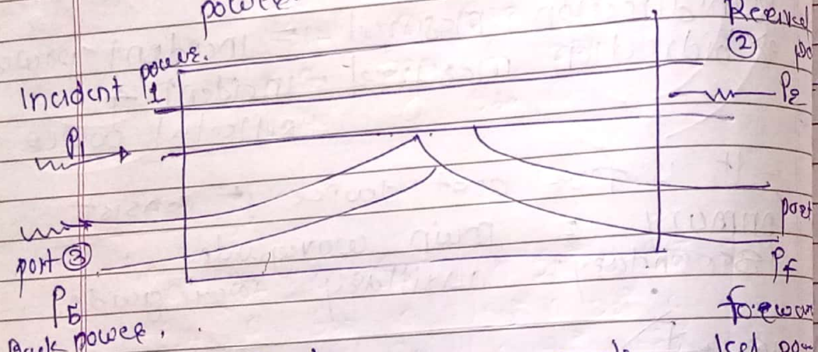
1) Unidirection measured = incident power
2) bidrection measured = incident + Reflected power.

- It is four port device it consist
primary = main waveguide.
secondary = auxillary wave guide.





ⓐ Schematic of directional coupler and power.



① $P_1 \xrightarrow{\text{couple}} P_2, P_4, \xrightarrow{\text{Not couple}} P_3$

② $P_2 \longrightarrow P_3, P_1 \not\longrightarrow P_4$

③ $P_3 \longrightarrow P_2 \not\longrightarrow P_1$

④ $P_4 \longrightarrow P_2 \not\longrightarrow P_3$

P_i = Incident power at port (1)

P_r = Received power at port (2)

P_f = forward couple power at port (4)

P_b = Back power at port (3)

① Coupling factor (C)

$$C = 10 \log_{10} \frac{P_i}{P_f} \text{ dB.}$$

② Directivity (D)

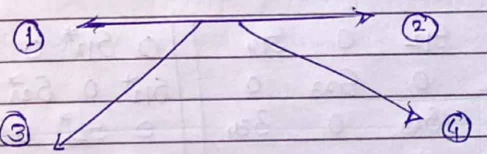
$$D = 10 \log_{10} \frac{P_f}{P_b} \text{ dB.}$$

③ Isolation (I)

$$I = 10 \log_{10} \frac{P_i}{P_b} \text{ dB.}$$

Isolation in dB = Coupling factor + Directivity

__Scattering matrix of A. Bidirectional Couple.__



$$[S] = \begin{bmatrix} S_{11} & S_{12} & S_{13} & S_{14} \\ S_{21} & S_{22} & S_{23} & S_{24} \\ S_{31} & S_{32} & S_{33} & S_{34} \\ S_{41} & S_{42} & S_{43} & S_{44} \end{bmatrix}$$

four port are match. $\longrightarrow$

$$S_{11} = S_{22} = S_{33} = S_{44} = 0$$

coupled ① & ③ and ② & ④

$$S_{13} = S_{41} = 0,$$

$$S_{23} = S_{32} = 0,$$

$S_{12} = S_{21}$, $S_{13} = S_{31}$, $S_{14} = S_{41}$

$S_{23} = S_{32}$, $S_{34} = S_{43}$, $S_{24} = S_{42}$

Symmetry property

$[S]^T$ $\boxed{S_{ij} = S_{ji}}$

$$[S] = \begin{bmatrix} 0 & & & 0 \\ & 0 & 0 & \\ & 0 & 0 & \\ 0 & & & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & S_{12} & 0 & S_{14} \\ S_{12} & 0 & S_{23} & 0 \\ 0 & S_{23} & 0 & S_{34} \\ S_{14} & 0 & S_{34} & 0 \end{bmatrix}$$

Identity

$$\begin{bmatrix} 0 & S_{12} & 0 & S_{14} \\ S_{12} & 0 & S_{23} & 0 \\ 0 & S_{23} & 0 & S_{34} \\ S_{14} & 0 & S_{34} & 0 \end{bmatrix} \begin{bmatrix} 0 & S_{12}^* & 0 & S_{14}^* \\ S_{12}^* & 0 & S_{23}^* & 0 \\ 0 & S_{23}^* & 0 & S_{34}^* \\ S_{14}^* & 0 & S_{34}^* & 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

* Forward port; ① & ②

$P_{12} = P_{21} = P$, $P_{34} = P_{43} = P$

* Coupled port

$P_{23} = P_{32}$, $P_{23} = P_{14} = \phi$ —— ②

$P_{14} = P_{41}$

$$\begin{bmatrix} 0 & P & 0 & \phi \\ P & 0 & \phi & 0 \\ 0 & \phi & 0 & P \\ \phi & 0 & P & 0 \end{bmatrix}$$

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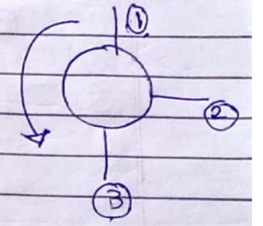
Determine the [S] of a 3-port circulator given insertion loss of 0.5 dB, isolation of 20 dB and VSWR of 2.

Given :→ i) Insertion loss $= 0.5$ dB

$= -20 \log [S_{21}]$

$|S_{21}| = 10^{-0.5/20}$

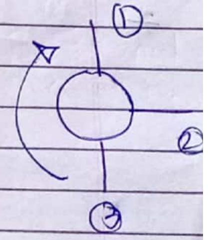
$$\boxed{S_{21} = 10^{-0.025}}$$



$S_{21} = S_{13} = S_{32} = 10^{-0.025}$

ii) Isolation $= 20$ dB

$= -20 \log [S_{12}]$



$S_{12} = 10^{-20/20}$

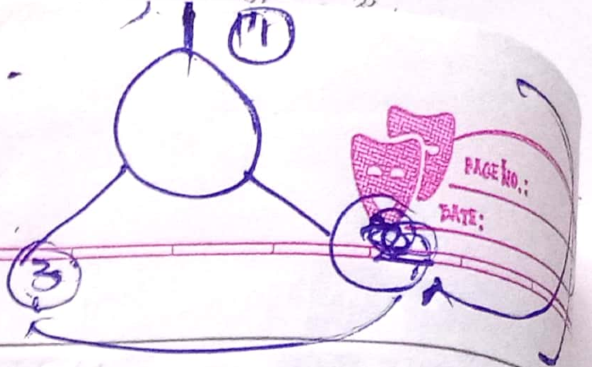
$S_{12} = 10^{-1}$ $\quad S_{12} = 0.1$

$S_{12} = S_{23} = S_{31} = 0.1$

$$\rho = \frac{VSWR - 1}{VSWR + 1} = \frac{2-1}{2+1} = \frac{1}{3} = 0.333$$

$S_{11} = S_{22} = S_{33} = 0.333$

$$\begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{22} & S_{23} \\ S_{31} & S_{32} & S_{33} \end{bmatrix} \begin{bmatrix} 0.33 & 0.1 & 10^{-0.025} \\ 10^{-0.025} & 0.33 & 0.1 \\ 0.1 & 10^{-0.025} & 0.33 \end{bmatrix}$$



NON Reciprocal:

$$\begin{bmatrix} 0 & 0 & S_{13} \\ S_{21} & 0 & 0 \\ 0 & S_{32} & 0 \end{bmatrix}$$

$\therefore S_{13} = S_{21} = S_{32} = 1$

$$\begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

*

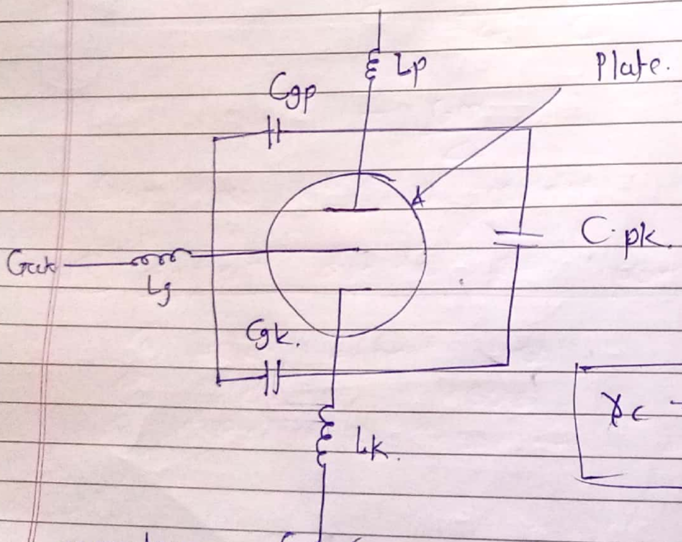
Unit-4 RMT (21)

Q3. (a) Elaborate on the HF limitation of Conventional tube.

- following are the five reasons because which conventional tubes does not use for Higher frequency more than 100MHz.

1. Interelectrode Capacitance effect.
2. lead Inductance effect.
3. Transit ~~Time~~ Time effect
4. Gain Bandwidth limitation
5. effect due to RF losses.

① Interelectrode Capacitance effect.



$$\boxed{X_C = \frac{1}{2\pi f c}}$$

operation. - if frequency ↑, Xc ↓ & O/P ↓ at ~~sh~~ due to shunt effect
- than ~~Xc~~ High Xc is short.

f - frequency ↑ than → ↑ than ↓ d.

(22)

Cgp & Cpk, Cgk is reduced. than area of electrode ↓ & distance of electrode ↑.

② lead Inductance effect (Same digram)

- frequency ↑ than $X_L = 2\pi f L$ ↑ →
- ↓ active electrode < V base ~~pt~~ pins.

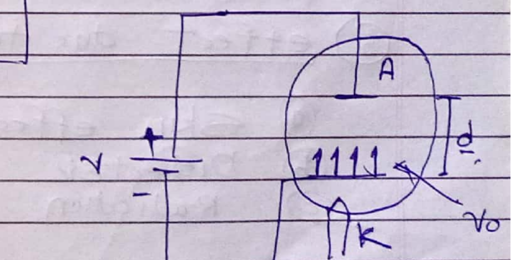
- Lp, Lg, Lk leading inductance.

- we can mimimized the effect of XL by d ↓ L. that time reduce the ~~H~~ power Handling capacity.

③ Transit Time effect.

Transit time effect that time betwenn electron flow from cathode to anode.

$$T \quad \boxed{\tau = \frac{d}{V_0}}$$

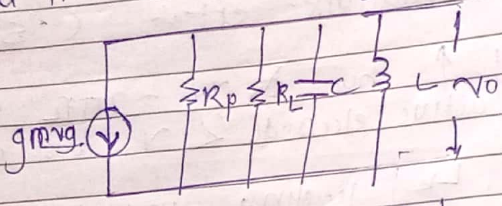


- f ↑ 'τ' ~~appecto~~ appreciable which ↓ V0.

- ~~Mt~~ mimimize of t 'd' is sepreted → electrod is ↓ & V0 ↑ →
- ~~o~~ Interelectrode capacitance & t are compens mx.

④ Gain Bandwidth product limitation.

- when the tuned circuit is Not resonance at that time max. gain is achived.



equivalent circuit

Gain Bandwidth product = Amax. Bω

$$= \frac{Gm}{\cancel{G}} \cdot \frac{\cancel{G}}{C}$$

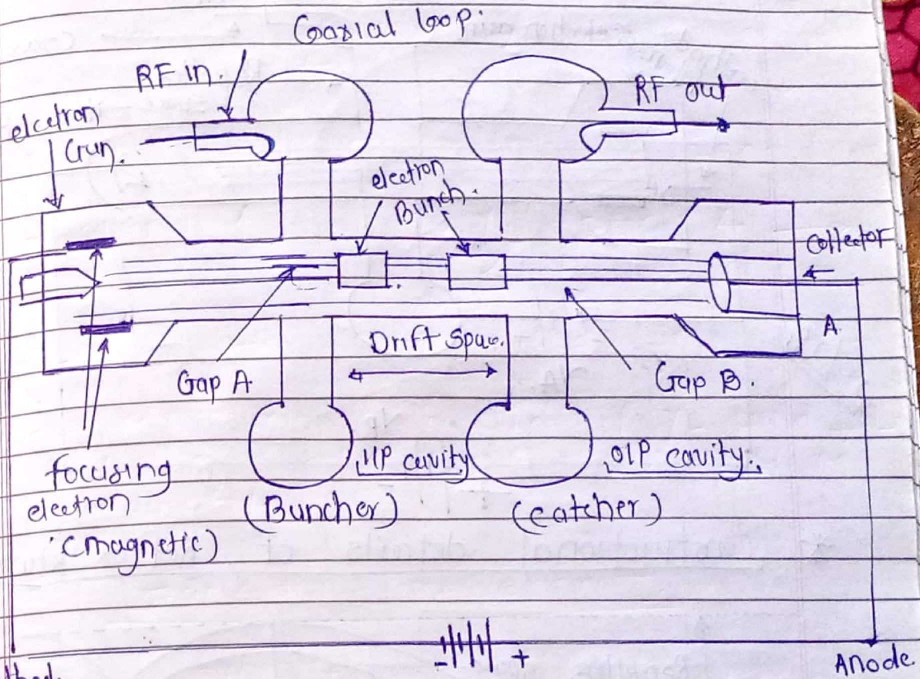
$$= \frac{Gm}{C}$$

Gain Bω product is dependent upone frequ.

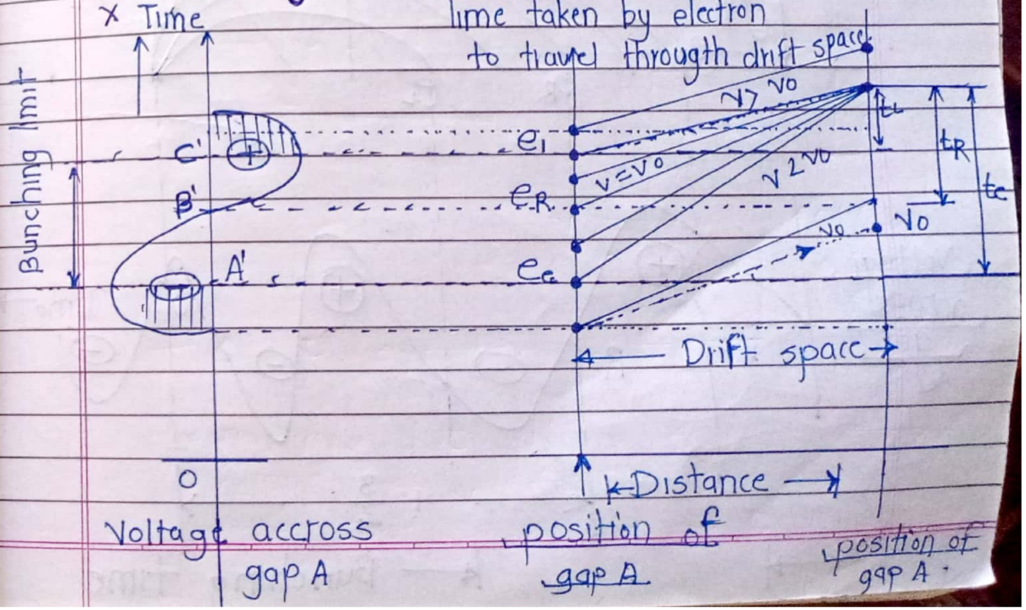
⑤ effect due to RF losses :—

ⓐ Skin effect losses.
ⓑ Dielectric losses.
ⓒ Radiation losses

* two cavity klystron Amplifier.



* Apple gate diameter of klystron amplifier.



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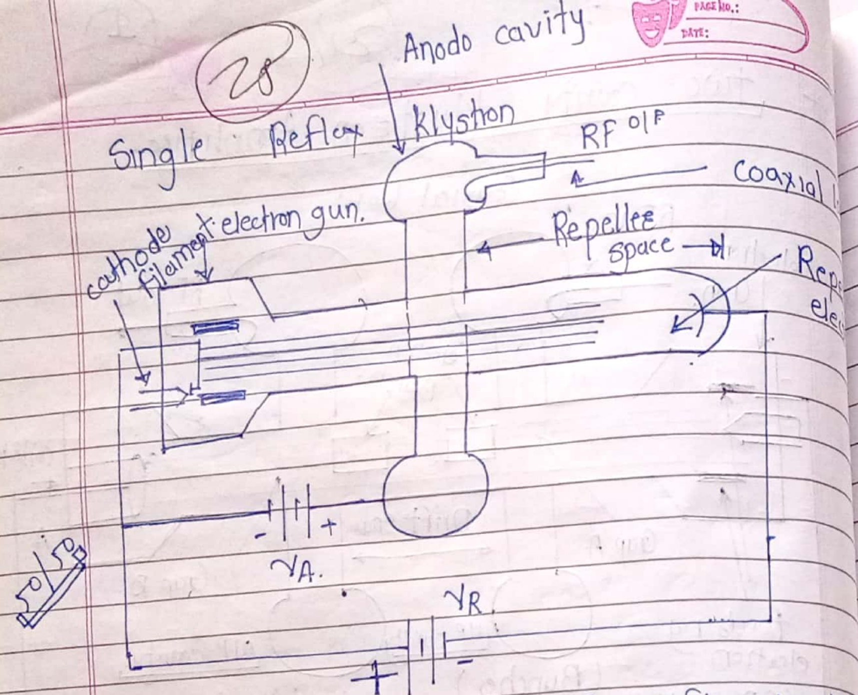
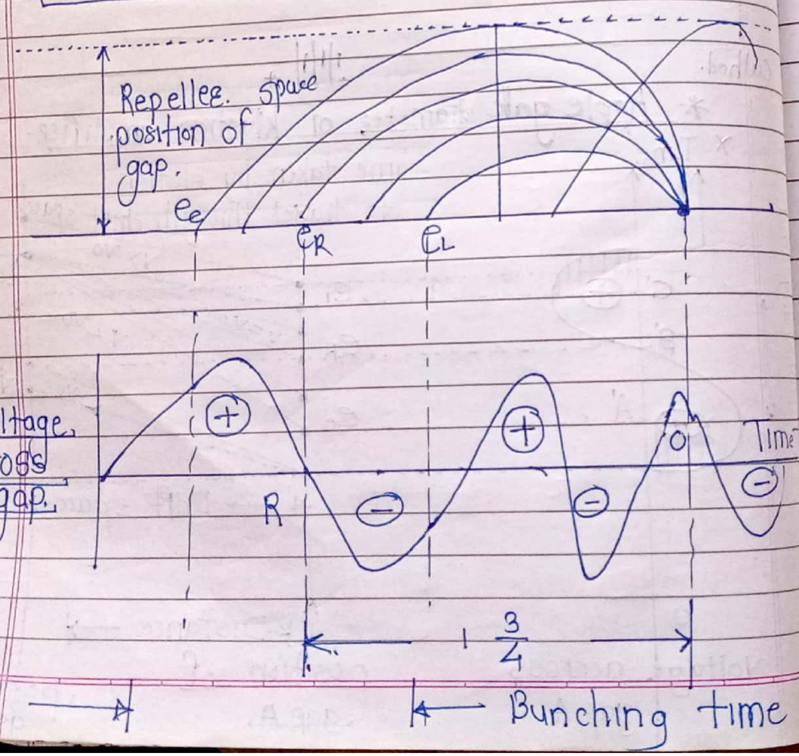
Single Reflex klystron



* Constructional details of Reflex klystron



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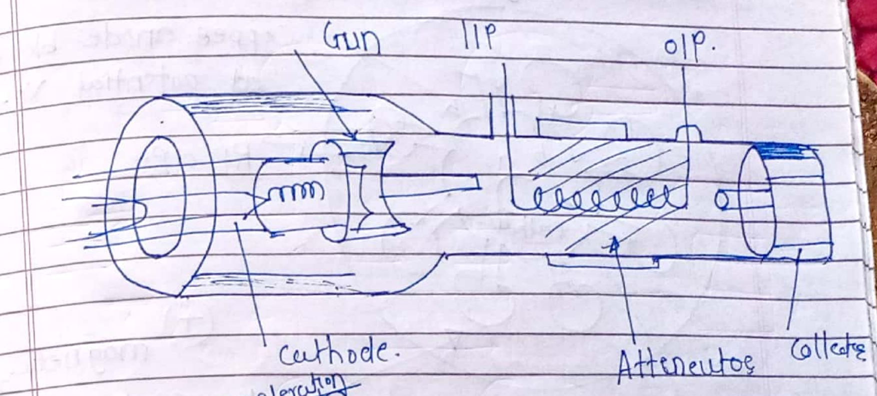
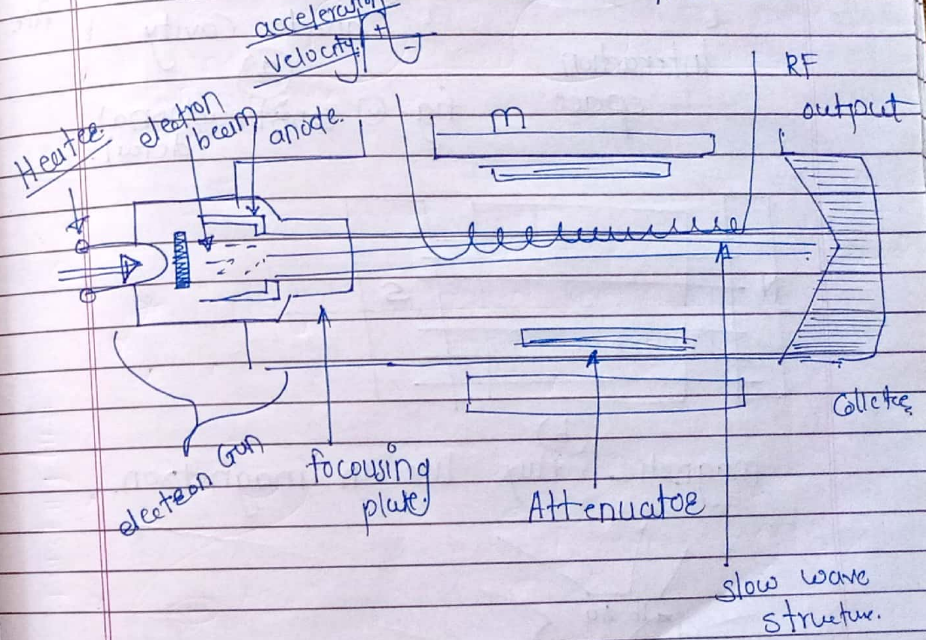
* Travelling wave Tube :→





* Cavity magnetron.

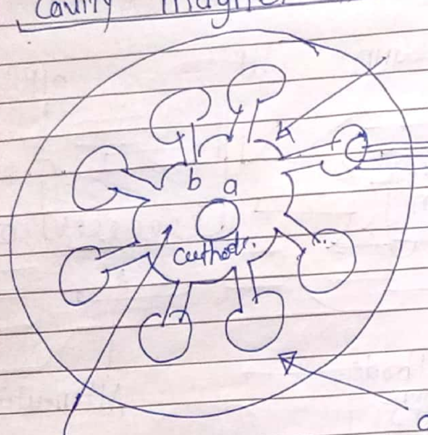
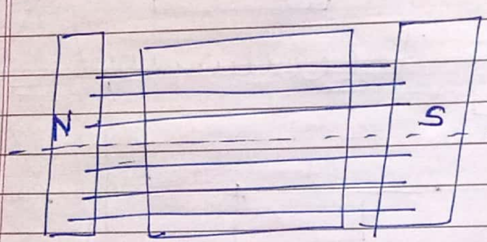
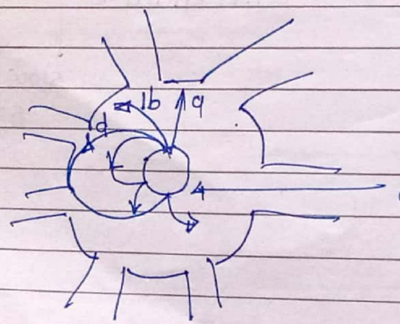
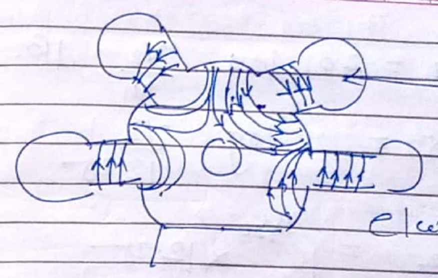


fig. (a) constructional detail.



(b)
magnetic flux line in magnetron.





$$\phi_v = \frac{2\pi n}{N}, \quad \text{where } n = 0, \pm 1, \pm 2, \pm \left(\frac{n}{2}-1\right), \pm \frac{N}{2}$$

$$n = \frac{N}{2}, \quad \phi_v = \pi.$$

(b) A 2 cavity klystron amplifier has the following characteristics : vtg gain = 15 dB.
I/P = 5 mV,
Rsh of I/P cavity = 30 kΩ
Rsh of O/P cavity = 40 kΩ
R_L (load impedance) = 40 kΩ

Determine :
(i) The input r.m.s. voltage.
(ii) The O/P r.m.s voltage.
(iii) The power delivered to the load.

(i) $P_{in} = \frac{V_1^2}{R_{sh}}$

$\therefore V_1^2 = P_{in} \times R_{sh}$

$= 5 \times 10^{-3} \times 30 \times 10^3$
0.005

$V_1^2 = 150$
$V_1 = 12.247$ V

0.75

(ii) $A_v = 20 \log \frac{V_2}{V_1}$ dB.

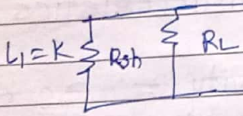
$15 = 20 \cdot \log \frac{V_2}{12.25}$

$V_2 = 10^{15/20} \times 12.25$

$\boxed{V_2 = 68.88}$ V.

(iii) $P_{out} = \frac{V_2}{R_{sh}}$

$P_{out} = \frac{68.88}{20K} = 237.3$ mW.



Klystron Tube — TWTA.

① ① It is a narrow band device — ① It is a wideband device

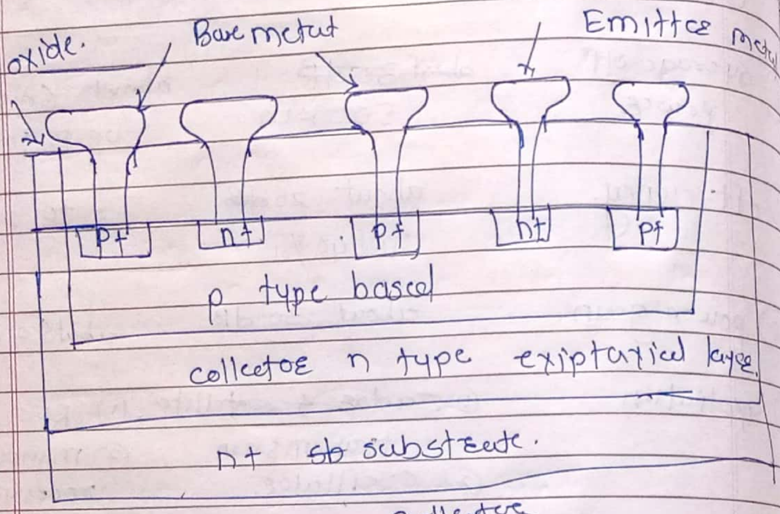
②

parameter	Klystron Tube.	TWTA.
① devices	Narrowband	wideband.
② Velocity modulation	using Cavity Resonator	using Non-resonant slow wave structure.
③ propagating wave	Not propagating	propagating wave.
④ average o/p power	~~about 30 dB~~ 500KW	about 60 dB up to 10 KW.
⑤ efficiency.	about 20 ~~dB~~ to 40 %	5 to 20 %
⑥ power gain	about 30 dB	about 60 dB
⑦ application	① Radar & satellite transmission ② oscillator.	① RF ② microwave receiver. ③ co-axial cable
⑧	Interaction between electron beam & RF field occur by across the cavity gap.	⑧ Continuous interaction between electron beam & RF field take place.

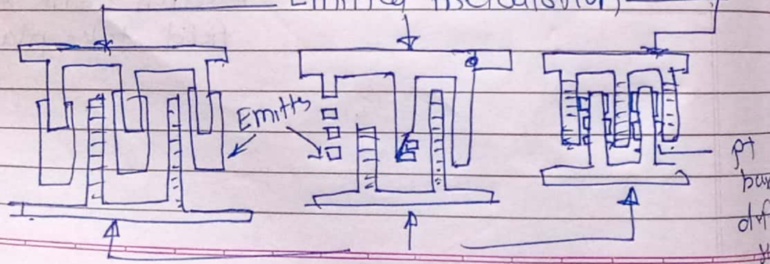
* Explain the constructional detail and operation of microwave Transistor

- n-p-n transistor. which provide required power at the microwave frequency, 5watt 3 GHz f, 5 dB gain.

- It consist double diffused expitaxial device.



- Geometry surface of transistor →
  - (a) Inter digitated Str - (C, L, S Band)
  - (b) Overlay (
  - (c) matrix (Emitter grid) VHF, UHF region



(b) Overlay Structure → - large number of emitter is overload through metal.

(c) ,

operation

1) In Microwave transistor, In C condition E-B & C are reversed baised.

2) If microwave signal applied between → E & B is forward bais. this junction is positive portion of the signal.

PNP transistor holes is p- region diffuse. than this holes is drift or flow throug the collector side. and collector is connected to the negative terminal of vtg so current flow through collector circuit.

Performance parameter

α, β and cut off frequency $f_{\alpha b}$, & $f_{\alpha e}$

where $\beta = \frac{\alpha}{1-\alpha}$ and $f_{\alpha e} = \frac{f_{\alpha b}}{\beta}$

f_{max} (m. f. of oscillator)

$$= \sqrt{\frac{f_T}{8\pi r_{B'} C_c}}$$

where C_c = Collector capacitor. $r_{B'}$ = Base resistance. f_T = cutoff frequency

Performance characteristics :→

① High o/p power at the lower band of microwave region.

② High operating power efficiency.

③ Large operating bandwidth.

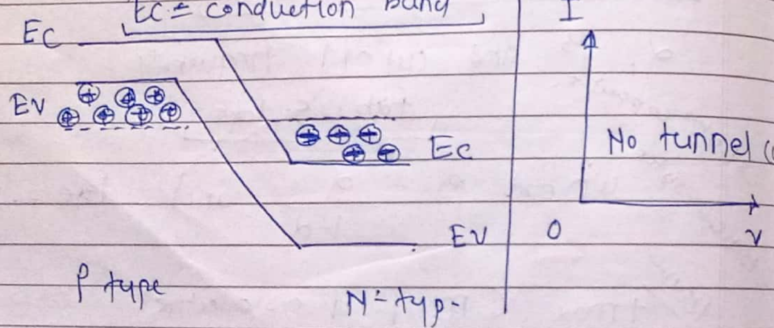
④ noise & distortion level is low.

Q ⓑ Tunnel diode :-

definition :→ The tunnel diode is heavily doped in P-N junction which is the electric current decreases as the voltage increase.

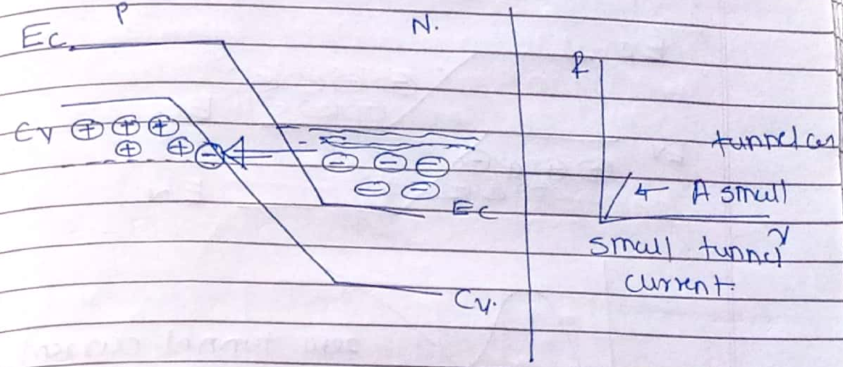
symbol :- A ─▶|─ K

operation :- Ev = valance band.
Ec = conduction band

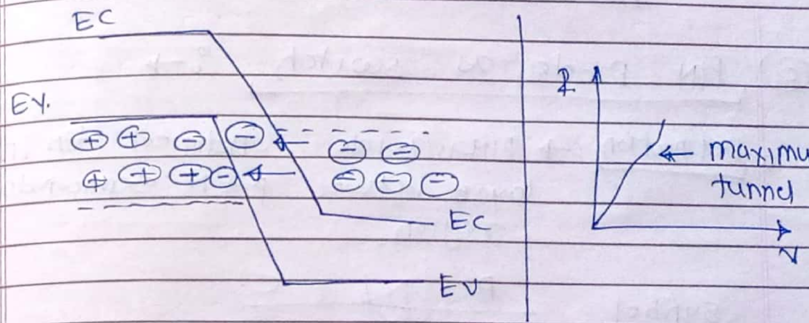


① Unbiased tunnel diode.

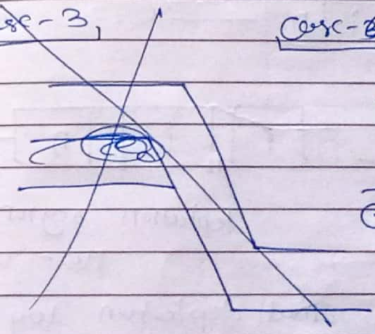
case → 2] Small vtg applied to the tunnel diode.



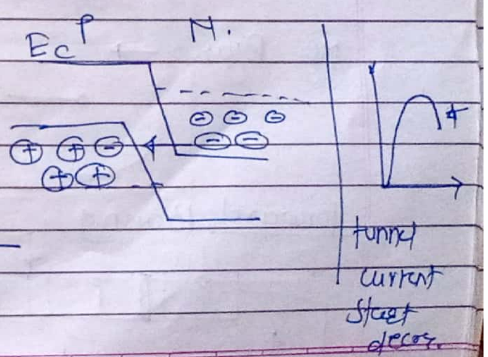
Case - 3. Applied vtg is slightly increase.



~~Case - 3.~~



Case - 4 Applied High vtg.



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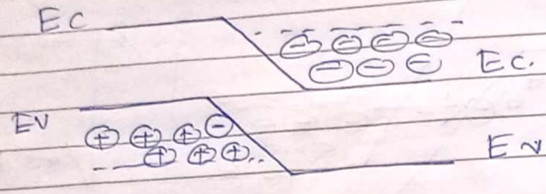
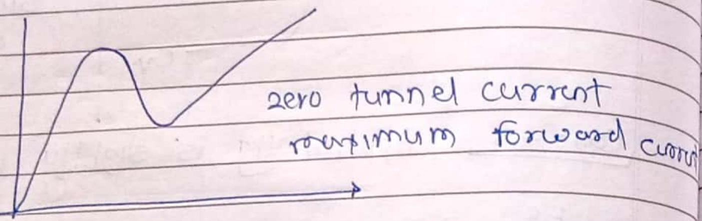
Case-5 | Vtg is largely increase

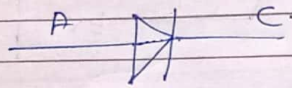


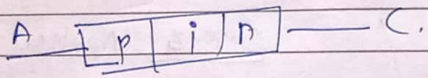


(c) PIN Diode as switch :→

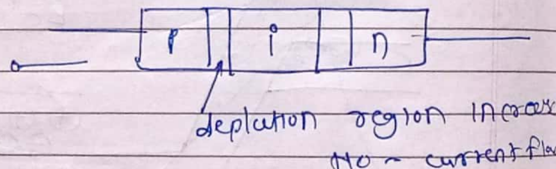
① Defination :→ PIN is wide - Undoped (in) Intrinsic layer betwee P & N Semiconductor region.

Synbol

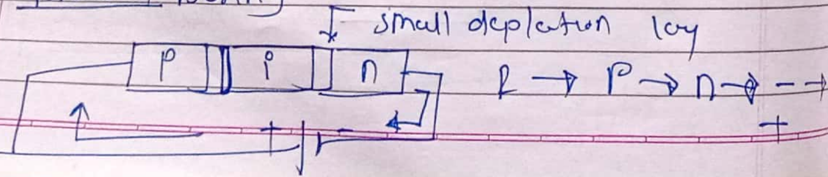




No Biasc →



Forward Biasing



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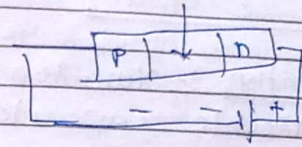
$V = IR$ $\quad \frac{V}{I\uparrow} = R\downarrow$ act as. variable. resistance

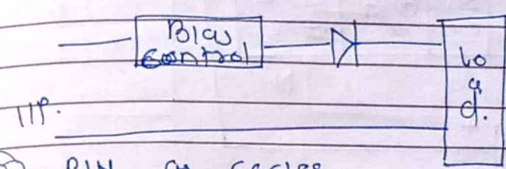
Reversed biasing



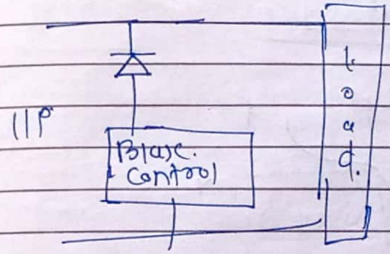
$$\downarrow C = \frac{\epsilon_0 A \uparrow}{d \downarrow}$$

act as varrable capacitance.

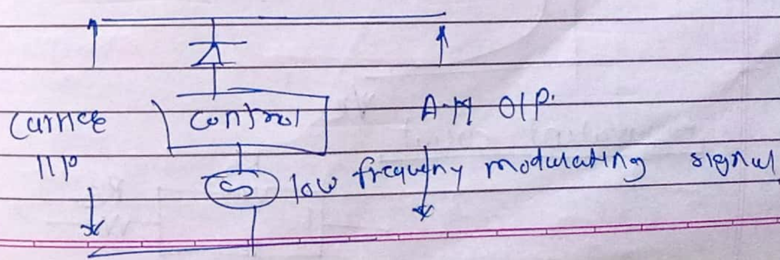
* PIN Diode as switch.



(iv) PIN as series.



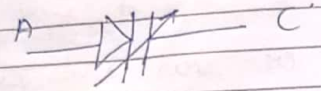
* PIN Diode as an Amplitude moduator

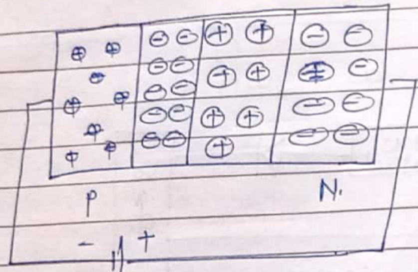


* ~~Vector~~ varactor diode.

Defination :- varactor diode is work as variable capacitor ~~when~~ but when ~~it~~ it in a reversed baised that called as varactor diode.

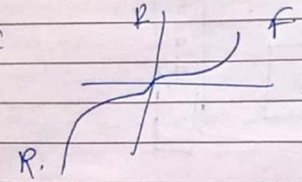
symbol :-



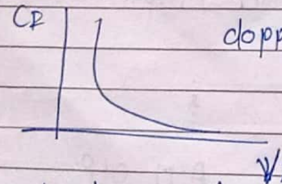


$$\boxed{C = \frac{\varepsilon A}{d}}$$

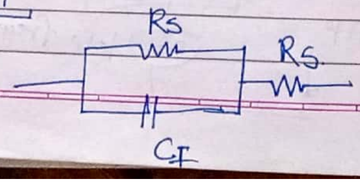
(b) V-I



(c) dopping profile.



equivalent circuit



application :- ① Harmonic Generation.
② tuning circuit
③ Vtg control oscillator, freq^n md
④ frequency multiplers.
(5) active filters.
~~(5) pulse~~
(6)

- what is TED ? (Transferred electron device)

- TED is two terminal or port device in which has ~~No~~ Negative resistange and no junction.

- Negative resistance mean the voltage and current have a 180° phase ship. it generate high power signal.

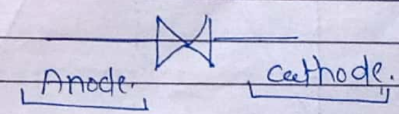
- It produced High power as compare to the MOSFET and BJT power.

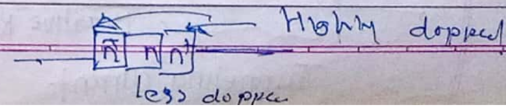
- It also called as oscillator.

* Gunn Effect device diode.

- It also known as TED

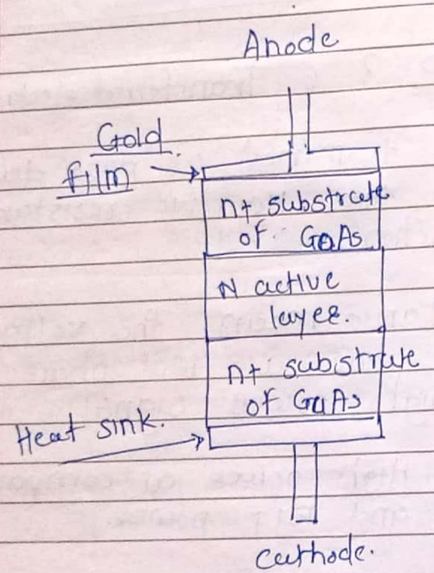
- Smbol e →

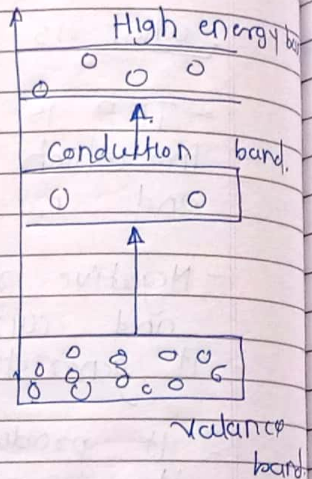




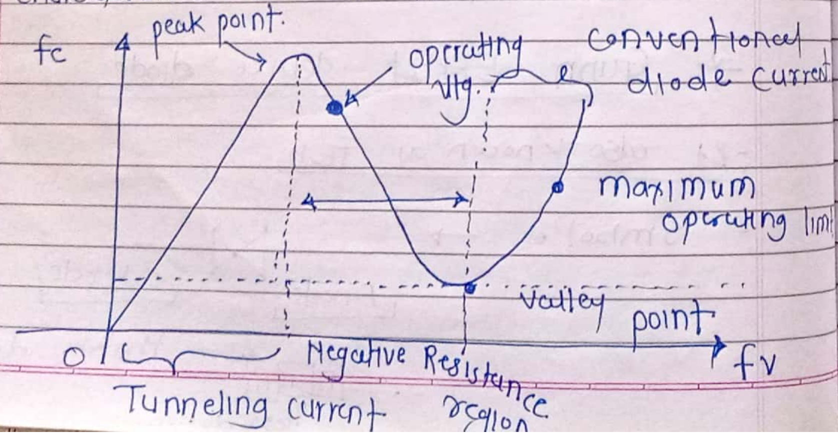
- The Gunn Eeffct is define as generation of microwave whenever the vtg applied to the semiconductor device that time critical vtg is exceed the OR threshould vtg value.

construction diagram,





Characteristics of Gunn diode. V-I

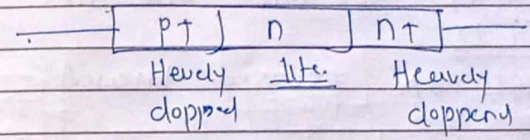


Advantages – compact in size.
- less noise
- & cheaper source
- operate on large BW & High frequency stability.

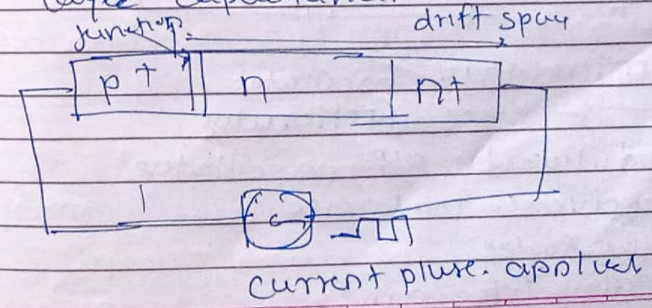
Application – RADAR
- Radio commⁿ
- Gunn diode oscillator.
- linear amplifier.

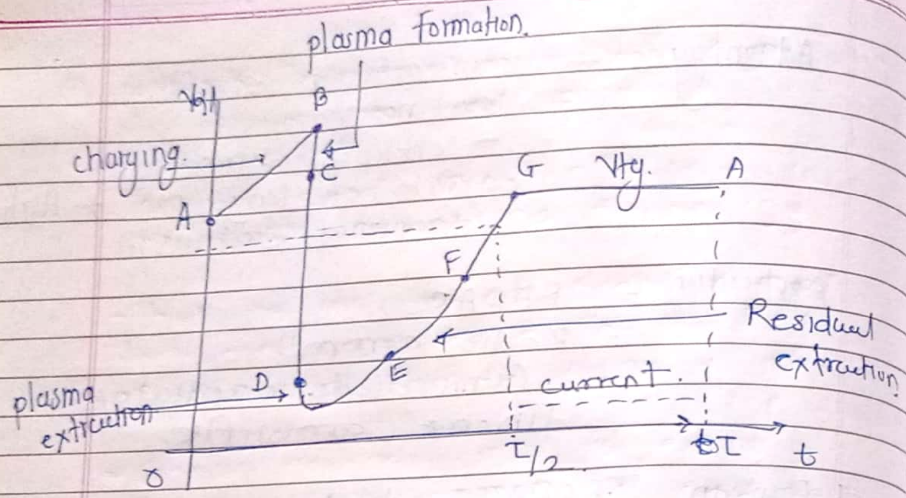
c] Explain TRAPATT diode.

- The TRAPATT – Trapped Plasma Avalanche Triggered transist.) diode.
- It operates efficently below 10 GHz.



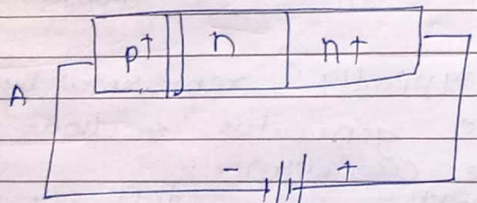
- It is typically represented by a current pulse generator & diode depletion layer capacitance.





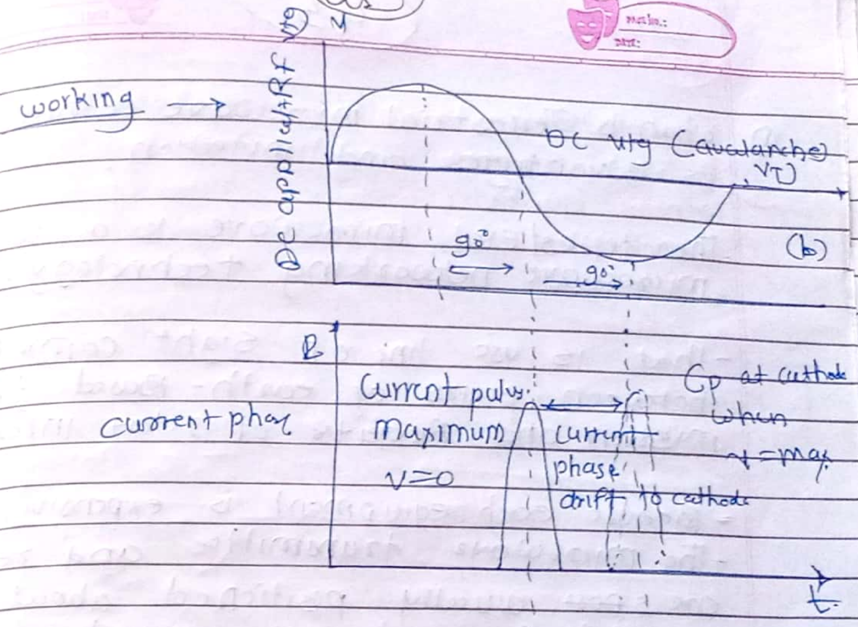
* IMPATT diode:-

- Impact ionization avalanche transit time diode
- It is RF semiconducted devices.
- It made by Si. GaAs and InP.
- TED
- ~~the~~ work on reversed biased



Appln
- Microwave oscillator
- — " — Generator
- modulated O/P oscillator.
- Receiver local osc
- Police Radar.
- FM Telecommn.

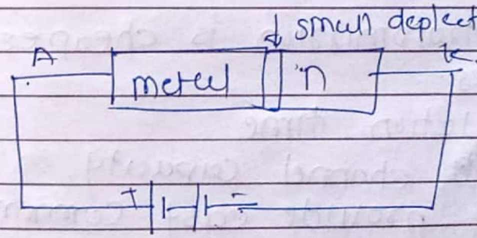
working →

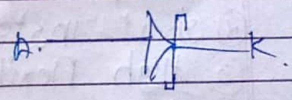


SCHOTTKY BARRIER DIODE (SBD)

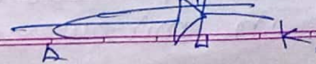
- ~~It is~~ It is metal semicondoer devices with low forward Vtg drop and very fast switching speed.

- It is used very High frequency and very High which ing speed.





Symbol



Unit-6

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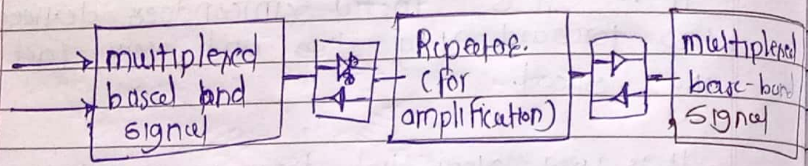
① what is Terrestrial microwave commⁿ sys. its advantages and limitation.

- The terrestrial microwave is a wireless microwave networking technology.

- That is use line of sight commn between pairs of earth-Based transmission and Receiver of relay information

- Beause each equipment is expensive,
- The microwave transmitter and receiver are ~~spot~~ usually positioned about ground level on towers, mountain tops, or buildings top.

~~advantages :→~~
~~① mi~~



advantages:→

① microwave transmission is cheaper than using cables.
② short installation time.
③ High Flexible channel capacity
④ These wave provide easy commn
⑤ commⁿ over the ~~ocean~~ oceans can be achive in microwave transmissio

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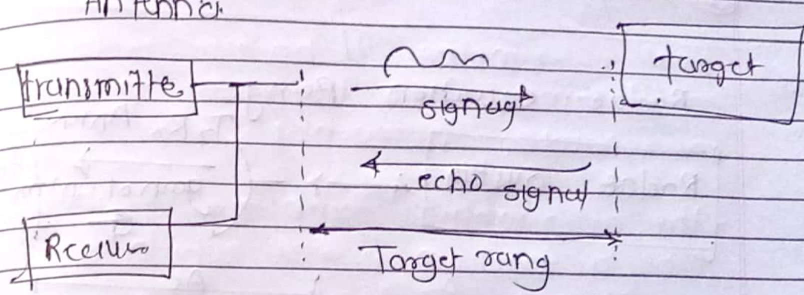
disadvantages:- ⓐ Eavesdropping.
② o/p out of phase signal
③ Bandwidth is limited.

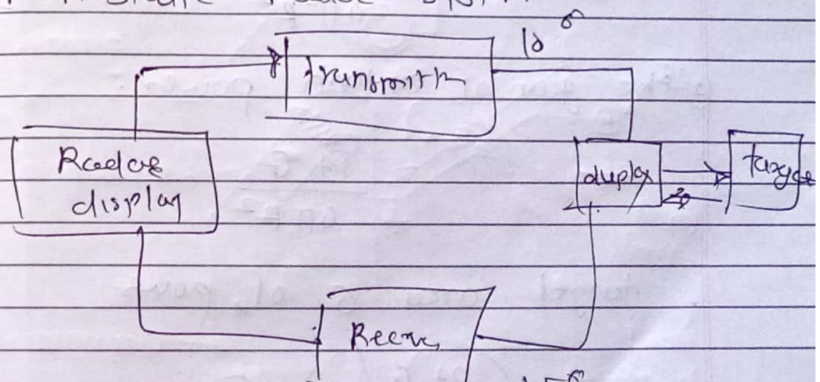
ⓑ block diagram of Radar.



Basic principle of Radar, Bistatic

Radio detection and

monostatic Radar system.



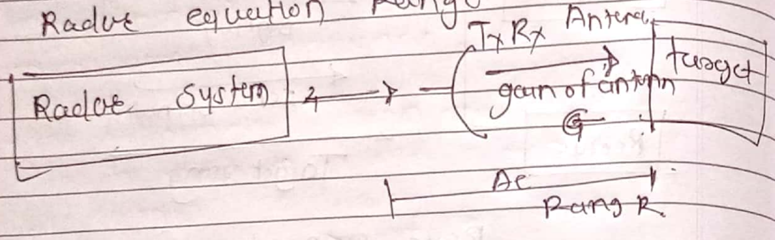
(47)

$T = \frac{D}{S}$ $S = \frac{D}{T}$ $\boxed{D = S \times T}$ $\boxed{2D = S \times T}$

monostatic
① single antenna
② need duplex
③ need less space
④ complex
⑤ costy

Bistatic.
~~do~~ two antenna
No need duplex
more space.
simple.
low cost system

Radar equation Range



① power density by isotropic source

$$= \frac{P_t}{4\pi R^2}$$

② the gain of antenn power.

$$= \frac{P_t G}{4\pi R^2}.$$

- target area σ of power

$$= \left(\frac{P_t \cdot G}{4\pi R^2}\right) \sigma$$

(48)

- Reflected power density.

$$= \left(\frac{P_t G \sigma}{4\pi R^2}\right) \times \frac{1}{4\pi R^2} = \frac{P_t G \sigma}{(4\pi R^2)^2}$$

effective area of antenna Ae, receive power

$$P_r = \frac{P_t G \sigma A_e}{(4\pi R^2)^2}.$$

for maximum range R_{max}, $P_r = S_{min}$

$$S_{min} = \frac{P_t G \sigma A_e}{(4\pi)^2 R^4_{max}} \Rightarrow R_{max} = \left[\frac{P_t G \sigma A_e}{(4\pi)^2 S_{min}}\right]^{1/4}$$

Hense parabolic antenna $\left[G = \frac{4\pi A_e}{\lambda^2}\right]$

$$R_{max} = \left[\frac{P_t \left[\frac{4\pi A_e}{\lambda^2}\right] \sigma . A_e}{(4\pi)^2 S_{min}}\right]^{1/4}$$

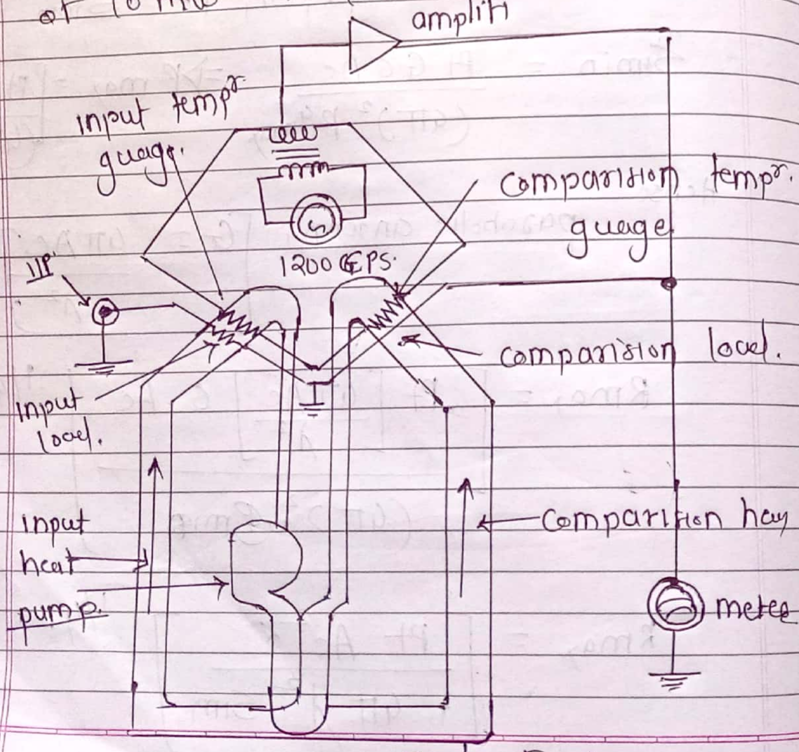
$$R_{max} = \left[\frac{P_t A_e^2 \sigma}{4\pi \lambda^2 S_{min}}\right]^{1/4}.$$

(67)

application :- ① military
② Air traffic controlling
③ ship safety
④ Remote sensing.
⑤ ~~rat~~

(c) How calorimeter technique is used for measurement of medium power at microwave frequency.

- The calorimetric technique is measured the a medium power which is range of 10 mw to 10 w.



Heat Exchanger.

(68)

Self balancing bridge technique.

- Unkwon I/P microwave power is sensed by the I/P load.

- when I/P applied to the comparision load Resistor it produce heat it transfer to the bridge.

- large amount of power applied to the comparision load Resistor. it is rebalanced bridge. It measure the the directly in terms of I/P microwave power.

(a) ⑧ medical application such as microwave Diathermy.