Model Question paper

Subject:- Digital Electronics

Faculty Name:- Nitin Suyan

Q = 1 convert following number system

(a) $(53.625)_{10} = (\quad)_2$

(b) $(100110101101)_2 = (2325)_8$

(c) $(2D5)_{16} = (\quad)_2$

Q = 2 perform following code conversion

(a) $[10110]_2 = [\quad]_G$

(b) $[0101111]_G = [\quad]_B$

(c) $[643]_{10} = [\quad]_{excess-3}$

Q = 3 Simplify the expression

(a) $AB + \overline{AC} + A\overline{B}C\,(AB + C) = 1$

(b) $\overline{\overline{A\overline{B}} + ABC + A(B + A\overline{B})} = 0$

Q = 4 Simplify the expression $Y = \sum_m (3, 4, 5, 7, 9, 13, 14, 15)$ using k-map

Q = 5 Design following ckt using Multiplexer

(a) OR gate

(b) full adder

Q = 6 Explain NOR based S-R Latch

Model Question paper Answer
Digital Electronics (Nitin Suyal)

Ans = 1 (a) $(53.625)_{10} = (110101.101)_2$

(b) $10011010101 = 010\ 011\ 010\ 101$
$\quad\quad\quad\quad\quad\quad\quad\quad 2\quad 3\quad 2\quad 5$

(c) $(2D5)_{16} = $ 2 D 5
$\quad\quad\quad\quad\quad 0010\ 1101\ 0101$

Ans = 2 (a) $[10110]_2 = $ 1 0 1 1 0 → 1 1 1 0 1 G

(b) $[1010111]_G = [\ \ ]_B$ 1010111 → 1100101 $= [1100101]_2$

(c) $[643]_{10} = $
643
+3 +3 +3
9 7 6
$1001\ 0111\ 0110 = 1001\ 0111\ 0110$

Ans = 3

(a) $AB + \bar{A}C + A\bar{B}C(AB + C)$
$= AB + \bar{A}C + A\bar{B}C$
$= \overline{AB} + \bar{A} + \bar{C} + \bar{B}C$
$= \bar{A} + B + \bar{C} + \bar{B}$
$= 1 + \bar{A} = 1$

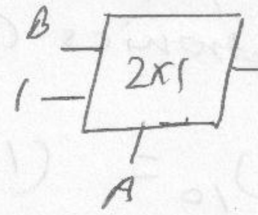
(b) $\overline{\overline{A\bar{B} + ABC} + A(B + A\bar{B})}$
$= \overline{\overline{A(\bar{B} + BC)} + A(B + A)}$
$= \overline{\overline{A\bar{B} + AC} + AB + A}$
$= \overline{\overline{A\bar{B} + AC} + A \cdot 1}$
$= \overline{\overline{A\bar{B}} \cdot \overline{AC} + A}$
$= \overline{(\bar{A} + B\bar{C}) + A}$
$= \overline{1 + B\bar{C}} = \bar{1} = 0$

Ans = 4

CD \ AB	00	01	11	10
00		1		
01		1	1	1
11	1	1	1	
10			1	

$Y = \bar{A}CD + ABC + A\bar{C}D + \bar{A}B\bar{C}$

Q Ans = 5 (a)



$\bar{A}B + A = (A+\bar{A})(A+B)$

$= (A+B)$

(b)

inputs			output	
A	B	Cin	S	C
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$S = \sum(1,2,4,7)$

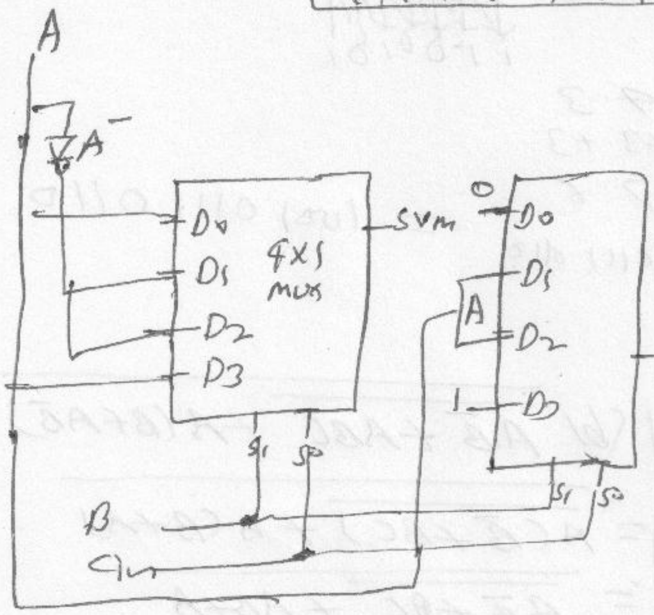
$C = \sum(3,5,6,7)$

A → i/p line

B, Cin → select line

SUM

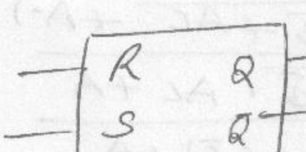
	D_0	D_1	D_2	D_3
$\bar{A}$	0	1	2	3
A	4	5	6	7
	A	$\bar{A}$	$\bar{A}$	A

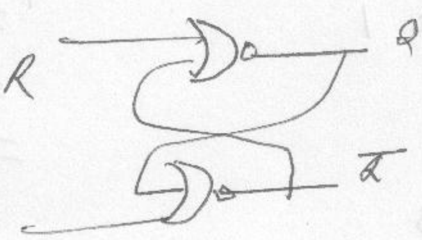


carry

	D_0	D_1	D_2	D_3
$\bar{A}$	0	1	2	3
A	4	5	6	7
	0	A	A	1

Ans = 6





S	R	Q_{n+1}	
0	0	Q_n	→ no change
0	1	0	→ Reset
1	0	1	→ set
1	1	?	→ Forbidden

Model Question paper

—————— x —————— x ——————

Subject :- Microwave Engineering
Faculty :- Nitin Suyan

Q=1 Explain construction, working of varactor diode ?

Q=2 Explain working of PIN Diode.

Q=3 Explain working of Tunnel Diode with Energy Band Diagram.

Q=4 Explain VSWR measurement techniquo.

Q=5 Explain construction, working of Reflex Klystron.

Q=6 Explain Construction working of TWT.

Q=7 Explain E-plane tee.

Ans = 1

(1) Varactor Diodes ! —

Varactor means variable reactor, Voltage variable capacitance of a reverse biased junction.
This is a S/C device whose junction capacitance Can be varied as a function of the reverse bias Voltage of the diodes.

$$C_J \propto \frac{1}{V_r} \propto V_r^{-n}$$

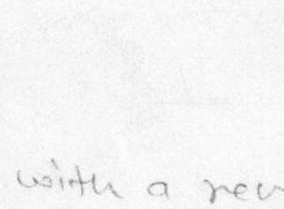
$n = 1/2$ = Junction is abrupt

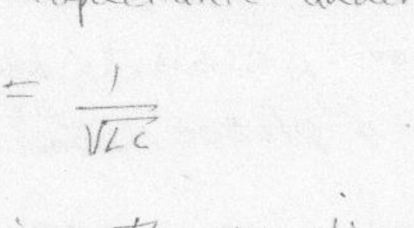
$n = 1/3$ = linear graded

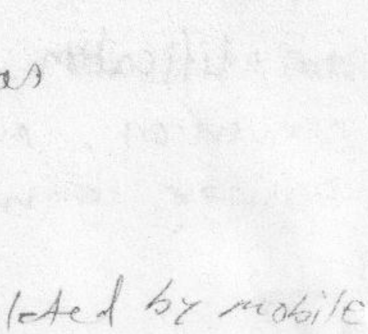
$$C_J \propto \frac{1}{V_r} \propto \frac{\epsilon A}{d}$$

$$V_r(\uparrow) \rightarrow d(\uparrow) \rightarrow C_J(\downarrow)$$

charge carrier depleted from junction





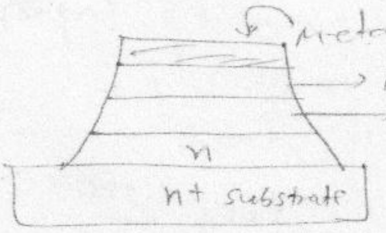


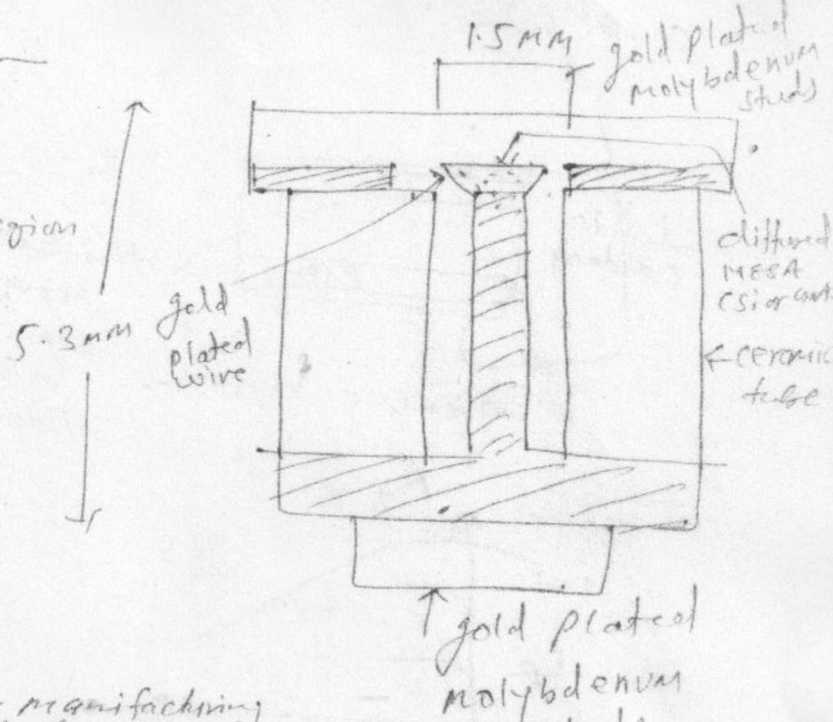
C_0 = capacitance under no bias

$$\omega_r = \frac{1}{\sqrt{LC}}$$

with a reverse bias the junction is depleted by mobile carriers resulting in capacitance i.e. the diode behaves as a capacitor with the junction acting as a dielectric between the two conducting materials. avalanche region is not used as it destroy the device

Construction diagram: —





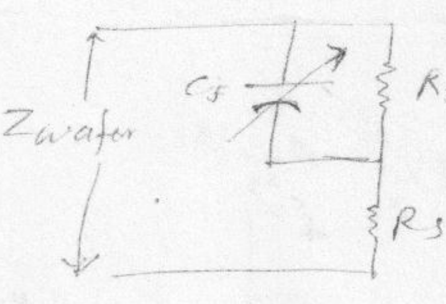
frequency limit

Si → 25 GHz → easy manufacturing techniques

GaAs → 90 GHz

better function at lowest temperatures

equivalent ckt →



R_J → junction resistance

R_S → series resistance including resistance of the wafer and the resistance of ohmic electrical leads

C_J → Junction Capacitance

Application →

(1) Harmonic generation

(2) MW frequency multiplication

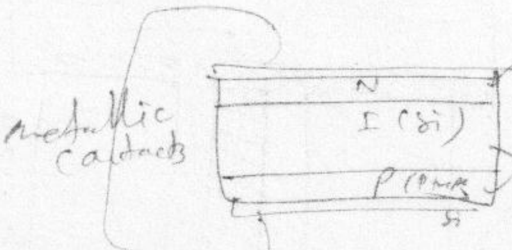
(3) switching ckt and modulation of a MW signal

(4) Tuning stage of a radio receiver

19/3/2014, 57, 59, 60, 61, 63, 65, 66, 67, 68, 69, 70, 71
41, 43, 46, 47, 50, 52, 53, 56, 58, 56
1, 3, 6, 8, 9, 10, 11, 12, 13, 15, 16
62 17, 18, 21, 22, 23, 24, 25, 26, 27
49 29, 30, 31, 32, 35, 37, 38, 39, 40

PIN Diode :-

Ans=2



Heavily doped n type layer (N type Si)

Si ⟶ power handling capacity
high resistivity
easy fabrication

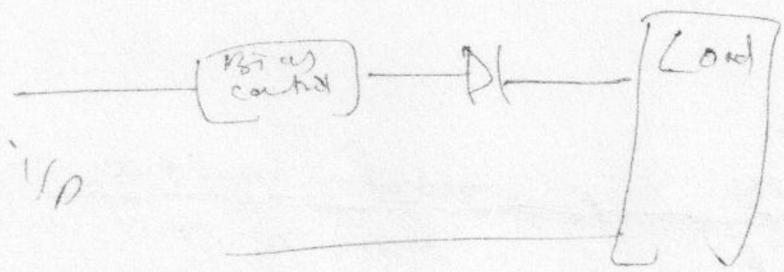
thicker layer of high resistivity materials
this is called intrinsic (very lightly doped material)

Variable resistor

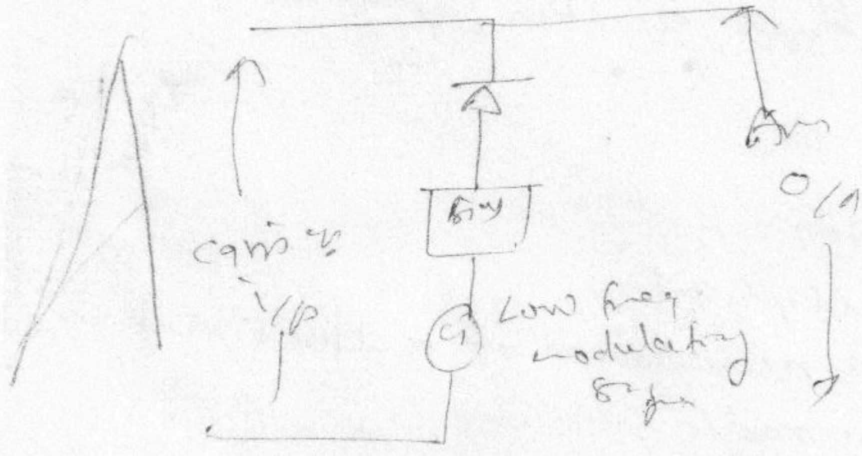
zero bias } High impedance
Reverse bias

forward bias
low freq → rectifier
100MHz → ordinary pn junction
High freq → variable resistor

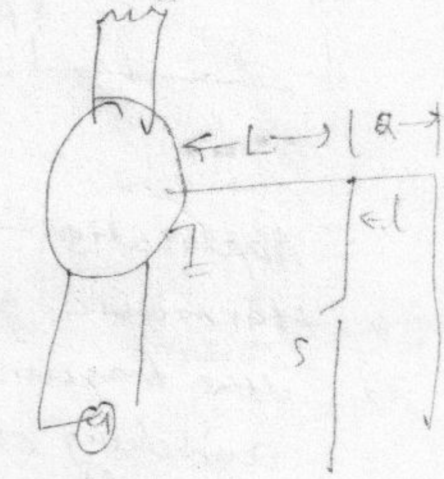
Pin as Switch



Am modulator



phase shifter



equivalent ckt

Ans=3 The Tunnel Diode →

A p-n junction diode has an impurity concentrati of about 1 part in 10^8 with the amount of dopi the width of the depletion layer is of order of 5 microns (5×10^{-4} cm). If the concentration of atoms is increased say 1 part in 10^3 (10^{19} atoms The device characteristics is completely changed Since the width of the junction barrier varies inversely as the square root of impurity concentratio hence it reduced from 5 microns to less than 100 A° (1 microns = 10^{-6}). At this very thin depletion layer tunneling of charge carriers takes place and this diode is called Tunne or Esaki Diode.

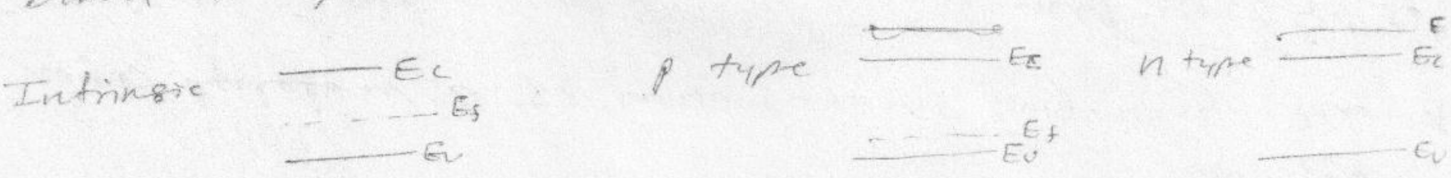
* The tunneling phenomenon is a majority carrier effect.

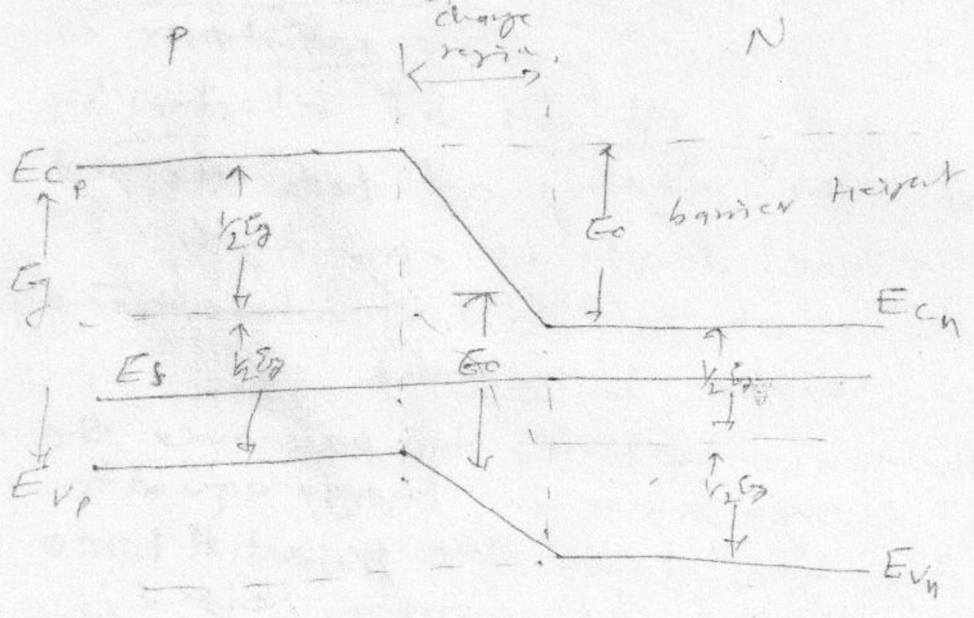
* The tunnel diode is a negative-resistance s/c p-n junction diode. This negative resistance is created due to tunneling effects of electron in the p-n junction. The doping of both the p & n regions of the tunnel diode is very high. impurity concentrations of 10^{19} to 10^{20} atoms/cm^3 a used and junction width 1 Microns.

It is possible for those particles to pass over the barrier if and only if they have an energy equal to or greater than the height of the potential barrie if quantum mechanically if the barrier height is less than 3A° the is sufficient probability that particles will tunnel through the potential barrier even they do not have enough kinetic energy to pass over the same barrier. In addition to barrier thinness there must also be filled energy states on the ~~other~~ side ~~into which~~ from which particles will tunnel and allowed empty states on the other sides into which particles penetrate through at the same energy level.

* Tunneling is a quantum mechanical phenomenon tunnel effect controls the current at very low values of forward bias.

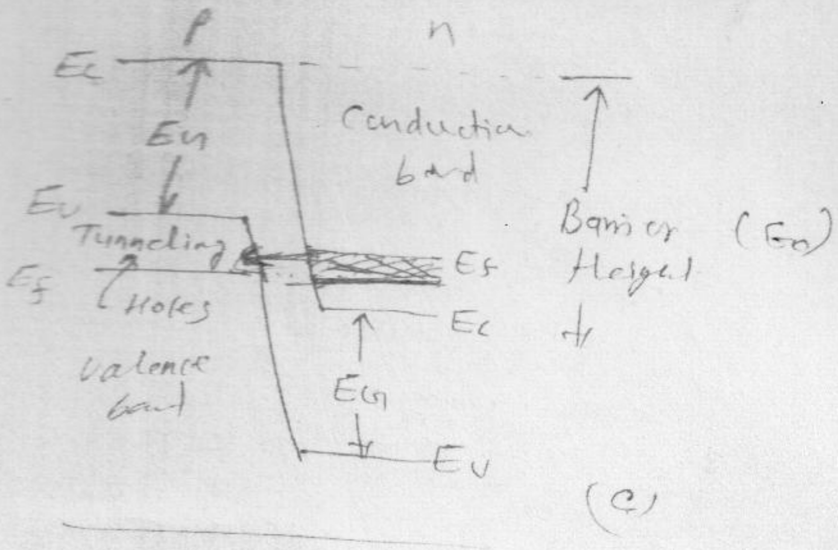
To under-stand the concept Let us see energy band diagram. we know that fermi level for





Energy gap for ordinary pn junction diode

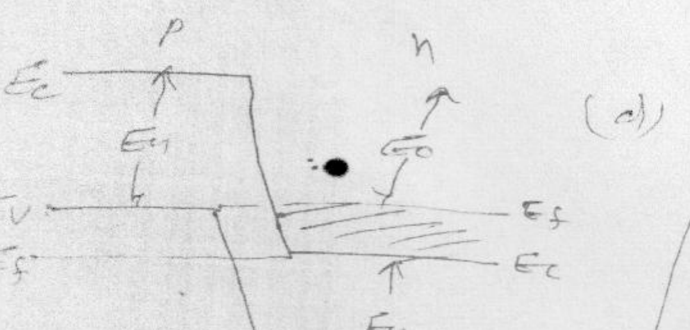
n.asim...gr



forward bias

(c)

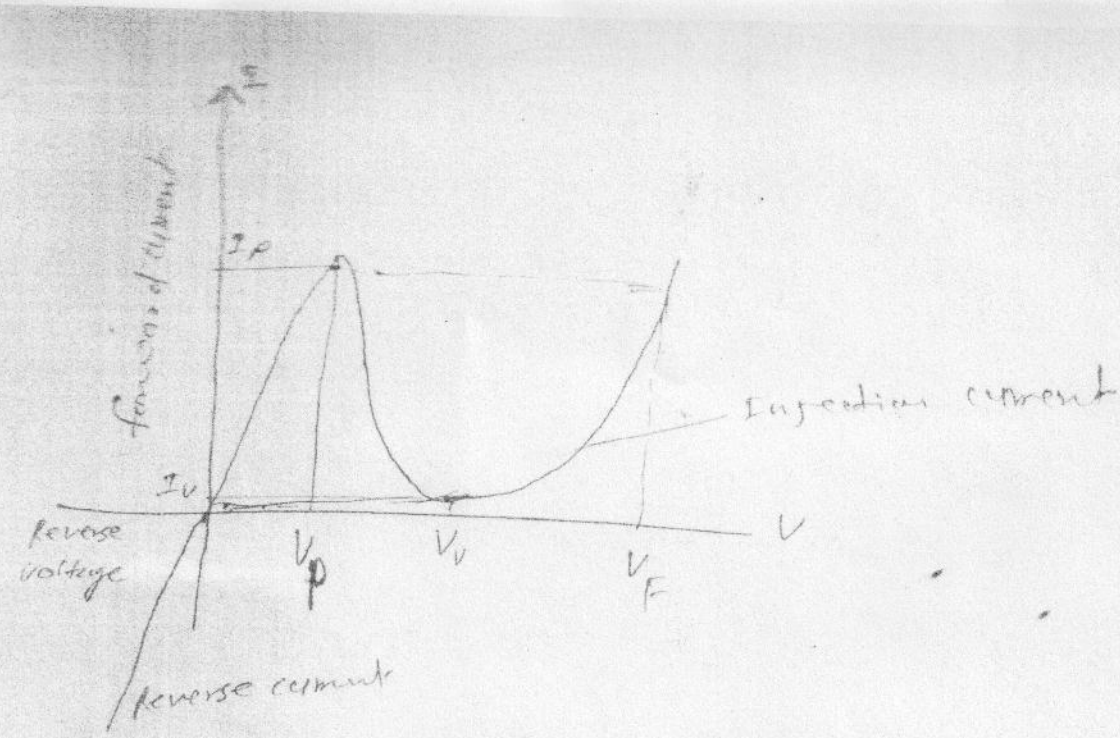
Now a forward is applied to the diode the potential barrier is decreased below Eo Hence n - side levels must shift upward with respect to p-side. Now there is occupied states in the conduction band of the n-material (heavily shado lines levels) which are at the same energy as allowed empty states (holes in the valence band of p side Hence electrons will tunnel from n to p side give rise forward current



(d)

As the forward bias is increased further condition d is obtained now in this case maximum numbers of electrons will tunnel from n to p side and constitute peak current I_p

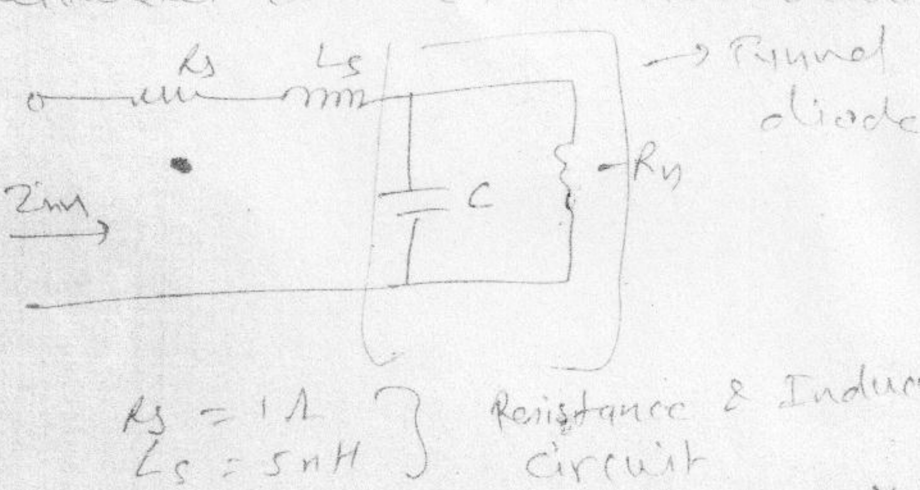
Barrier Height is decreased more. Hence n side level is shift more upword at with respect to p side



V-I characteristics

	Ge	GaAs	Si
$\frac{I_p}{I_v}$	8	15	3.5
V_p	.055	.15	.065
V_v	.35	.50	.42

equivalent ckt of tunnel diode



$R_s = 1\Omega$, $L_s = 5nH$ } Resistance & Inductance of package circuit

$C = 20PF$ → Junction capacitance at valley point

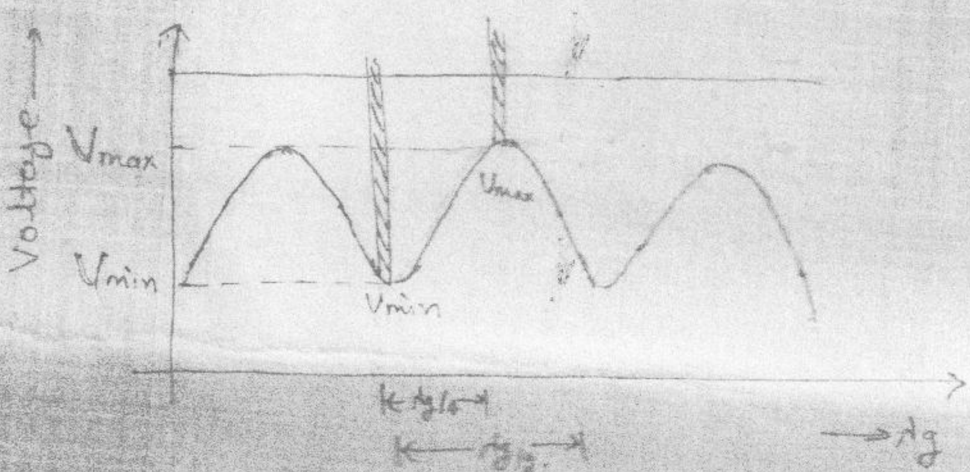
Input impedance → $R_s + j\omega L_s + \dfrac{R_n\left[J/\omega C\right]}{-R_n - J/\omega C}$

Ans = 4

(5) Measurement of voltage standing wave ratio (VSWR)

$\longrightarrow$

Any mismatched load leads to reflected waves resulting in standing waves along the length of the line. The ratio of maximum to minimum voltage gives the VSWR as shown by below fig. [Condition of VSWR is $Z_L \neq Z_0$]



$$VSWR = S = \frac{V_{max}}{V_{min}} = \frac{1+\rho}{1-\rho}$$

where ρ = reflection coefficient $= \frac{P_{reflected}}{P_{incident}}$

P_{ref} = reflected power

P_{in} = incident power

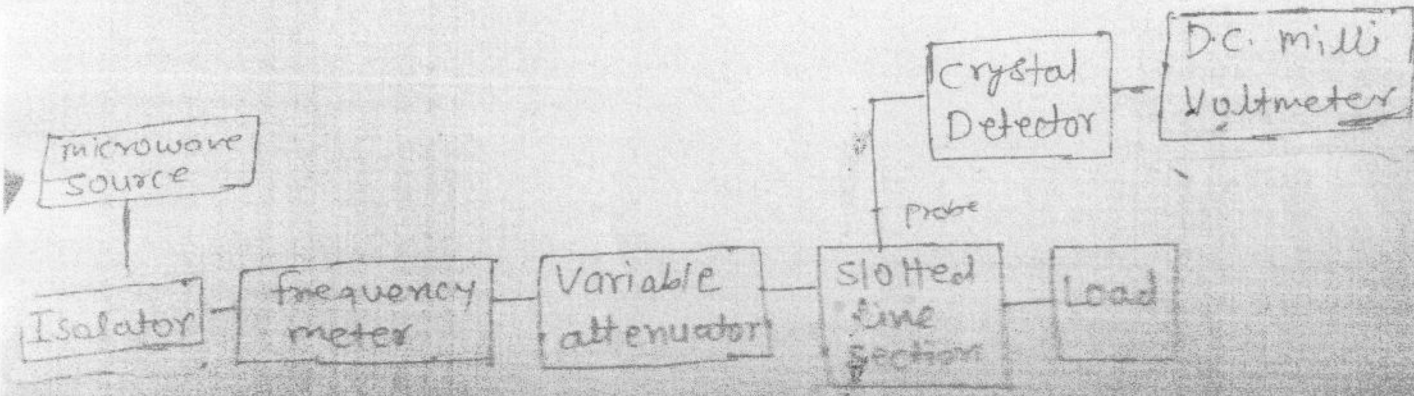
S varies from 1 to ∞

as ρ varies from 0 to 1

Hence maximum value of S is unity

(i) Measurement of low VSWRs ($S<10$)

Value of VSWR not exceeding to 10 are very easily measured with the set up as shown in below figure (a).



[illegible]

[illegible] reading on the meter (corresponding to [illegible] V_{max})

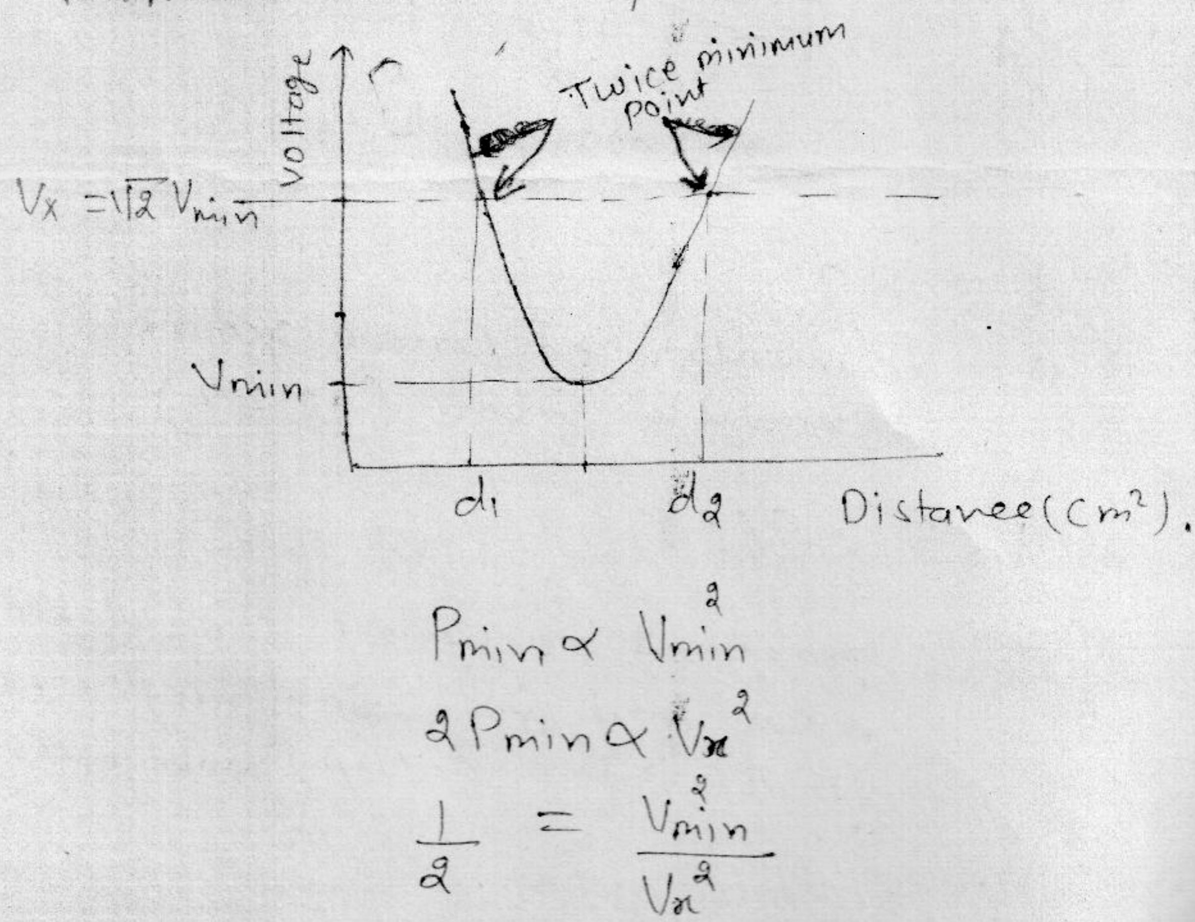
(iii) The attenuation is now adjusted to get full scale reading. The full scale reading is note down.

(iv) Next adjust the probe on the slotted line to get minimum reading on the meter (corresponding to V_{min}).

(v) The ratio of first reading to second reading ie (V_{max}/V_{min}) gives the VSWR.

(ii). Measurement of high VSWR (S>10)

for VSWR's > 10 we use the double minimum method. In this method the probe is inserted to a depth where the minimum can be read ~~directly~~ without difficult[y]. The probe is then moved to a point where the power is twice the minimum. Let this position is denoted by d_1. The probe is then moved to other side of minimum to get twice power of minimum. Let this position is denoted by d_2



$$P_{min} \propto V_{min}^2$$

$$2P_{min} \propto V_x^2$$

$$\frac{1}{2} = \frac{V_{min}^2}{V_x^2}$$

$$\boxed{V_x = \sqrt{2}\,V_{min}}$$

VSWR's can be calculated by the following formula.

$$\boxed{VSWR = \frac{\lambda_g}{\pi (d_2 - d_1)}}$$

λ_g may be calculated as

for TE_{10} mode

$$\lambda_g = \frac{\lambda_0}{\sqrt{1 - \left(\frac{\lambda_0}{\lambda_c}\right)^2}}$$

$\lambda_c = 2a$

$a =$ dimension of wave guide should be given ($a = 2.2$)

$\lambda_0 = c/f$

$f =$ practical frequency should be measured from frequency meter in the given setup [wave meter technique

(3) Reflex Klystron →

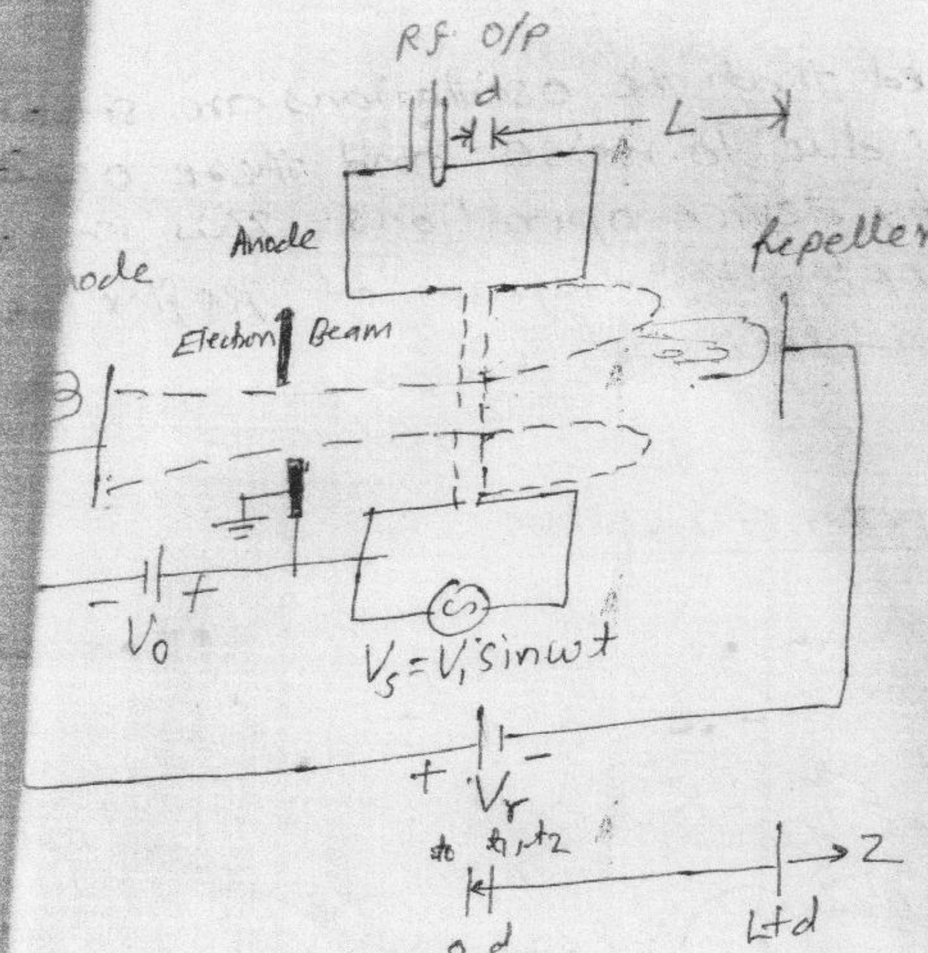
Ho=5

A two cavity klystron oscillator is usua
constructed because when the oscillations fre
is varied the resonant frequency of eacl
and feedback path phase shift must be r
for a positive feedback. To overcome this a
klystron is used.

The Reflex klystron is a single cavity variable frequency microwave generator which works
oscillator.

(3.1) Construction →

(a) Cathode-anode configuration (electron gun) - produce an accelerated electron beam
(b) Cavity (Resonator)
(c) pair of cavity grids (gap)
(d) Repeller electrode which is at a negative potential with respect to the cathode
(e) output coupling loop.
(f) d = distance between gap of cavity
(g) L = distance between gap and Repeller
(h) t_0 = time for electron entering cavity gap $Z=0$
(i) t_1 = time for same electron leaving cavit at $Z=d$
(j) t_2 = time for same electron returned by retarding field $Z=d$ and collected on of cavity.



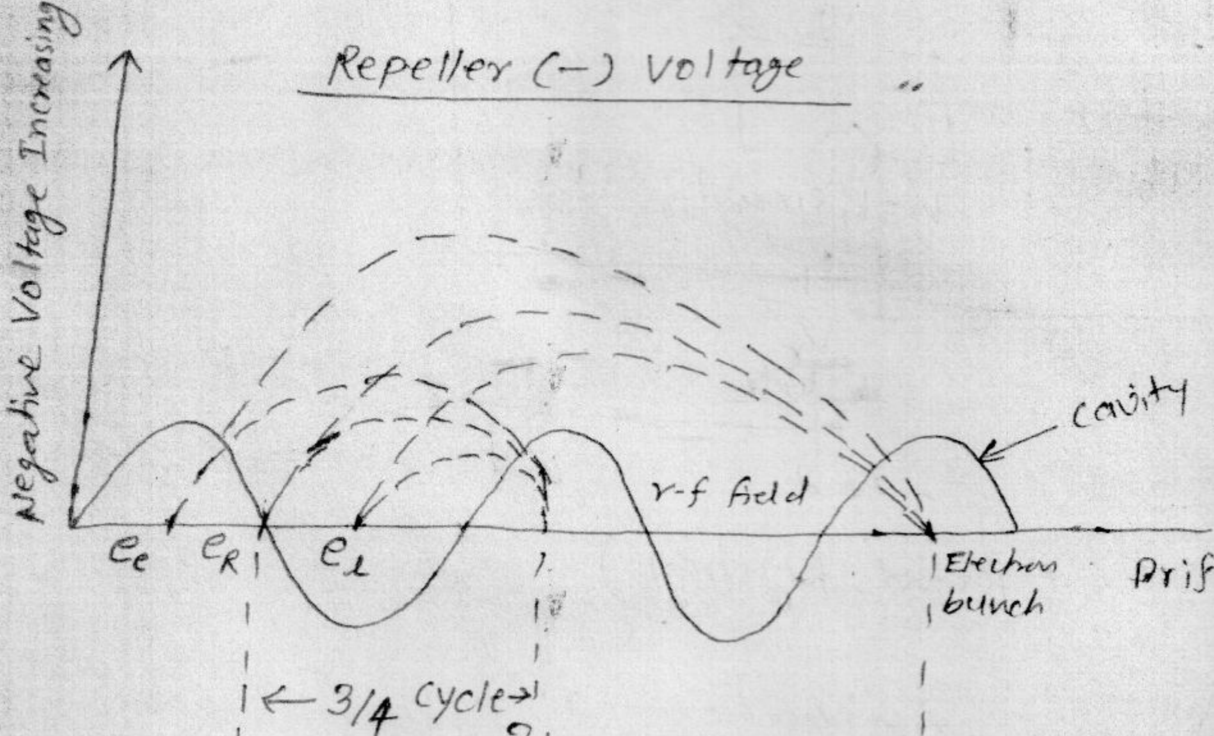
(Reflex klystron)

working principal ⟶

The electron beam is accelerated towards the anode cavity (at positive potential). After passing the gap in the cavity, electrons travel towards repeller electrode which is at high negative potential V_r. The electrons never reach the repeller because of the negative field and are returned back towards the gap. Under suitable conditions, the electrons give more energy to the gap than they took from the gap on their forward ~~journey~~ journey and oscillations are sustained.

(33) operation →

It is assumed that the oscillations are set
the tube initially due to noise and these os
are sustained by device operations. This ca
explained by applegate diagram of Reflex
that is shown below.



{ Applegate diagram }

e_e = early electron
e_R = reference electron
e_l = late electron.

The RF voltage that is produced across the
by the cavity oscillations act on the electron
to cause the velocity modulation.

reference electron that passes through the
n the gap voltage is 'O' (zero) and going
Electron 'e_R' is unaffected by the gap voltage
s towards the repeller and gets reflected
gative voltage on the repeller. It returns
ses through the gap for a second time.

ly electron 'e_e' that passes through the gap
e reference electron 'e_R' experiences a maximum
voltage across the gap and this electron is
ted. It moves with greater velocity and
rates deep into repeller space. The return time
lectron 'e_e' is greater as the depth of penetration
the repeller space is more. Hence 'e_E' and e_R
ar at the gap for the second time at the same

nt:

late electron 'e_l' that passes the gap later than
ence electron 'e_R' experiences a maximum negative
age and moves with a retarding velocity. The
rn time is shorter as the penetration into
eller space is less and catches up with 'e_R' and
electron forming a bunch. Bunches occur once
cycle centred around the reference electron 'e_R'
these bunches transfer maximum energy to the
p to get sustained oscillations.

(1) ~~is a linear beam tube~~

TWT

TWT is a linear beam tube It works as amplifier i.e. It amplifies the R.f input. It is used for broad band application where the high average power is required as in Radar transmitter

(ii) Construction :—

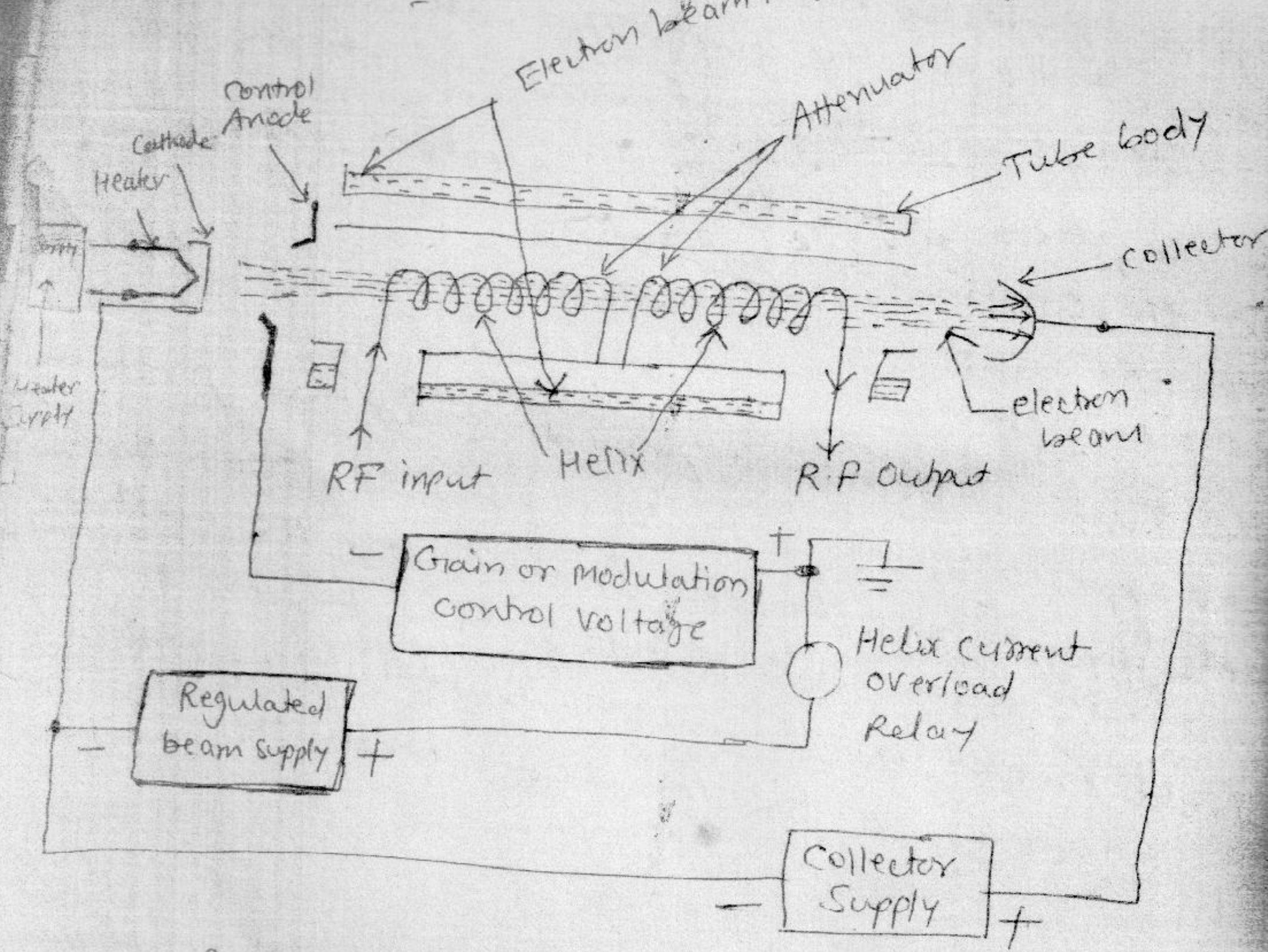
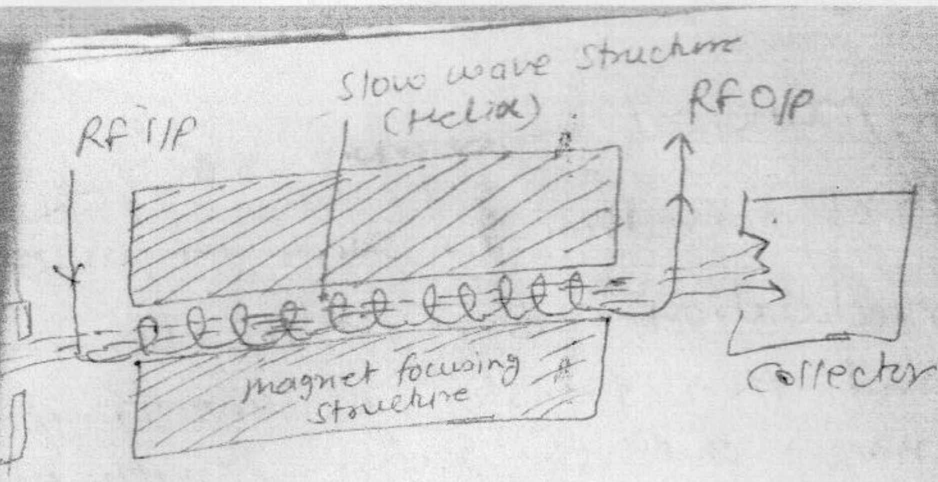


Diagram of Helix traveling wave tube.



(Simplified diagram)

An electron gun between cathode and anode providing constant velocity electron beam passing through the axis of the TWT

A long slow wave structure (non resonant) called helix through ~~which~~ the turns of which RF signal from the input waveguide propagates. The RF propagates with the velocity of electromagnetic propagation. It produces an axial RF field whose velocity is not same as the RF signal but it reduces by the ratio of the pitch of the helix to the circumference of the helix

The helix has a retarding mechanism to slow down the RF velocity thatswhy it is also called slow wave structure

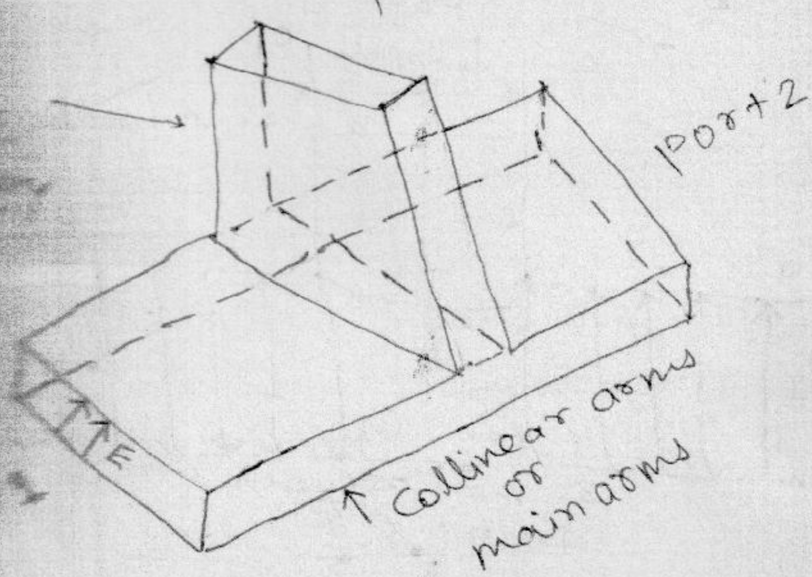
A collector which is generally kept at a dc potential lower than that of the helix

V.Imp
e) There is an attenuator at the centre of the circuit which absorbs the reflecting wave from mismatch at the output

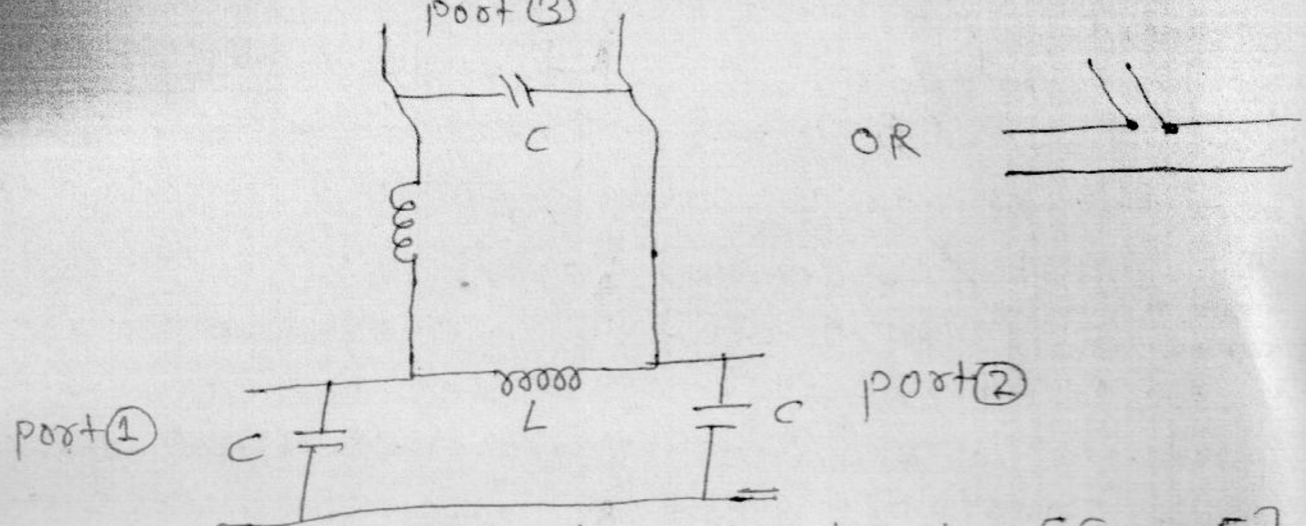
(f) The magnet produces an axial magnetic field to prevent spreading of the electron beam as it travels down the tube tee or Series tee ⟶ or subtractor

plane tee is a waveguide tee in which side arm is parallel to the E field guide or collinear arms. In this tee field is parallel to the side arm's axis is also known as voltage junction in electric field.

shows the E-plane tee



E-type tee
(Figure-4)



equivalent circuit of E-plane tee [Figure-5]

Now we will discuss the various cases when power is entered in different port of E-tee

① If the input TE_{10} wave is fed to the side arm which is placed at the centre of the collinear arm the output at port 1 and 2 will be equal but in opposite phase as shown in below figure 5.

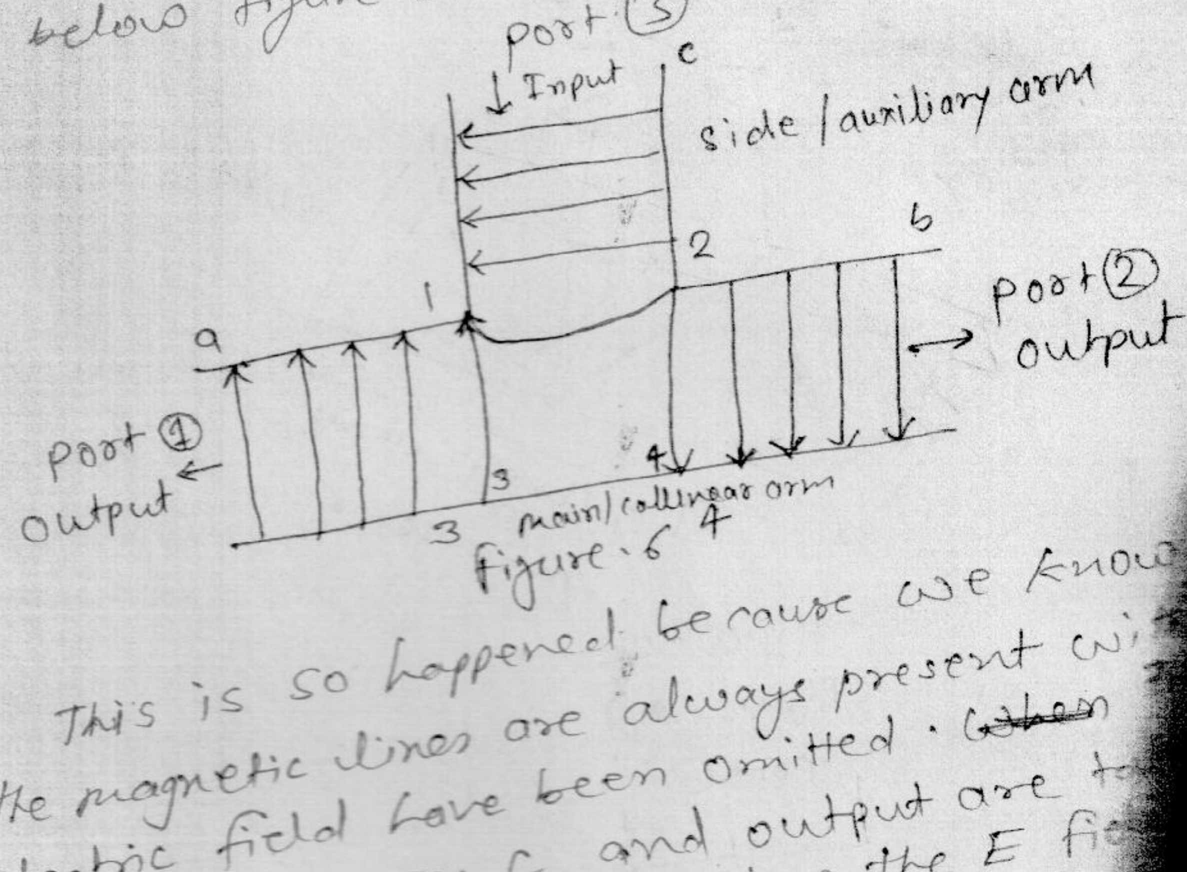


figure. 6

This is so happened because we know the magnetic lines are always present wi... electric field have been omitted. ~~When~~ ... is fed into arm c and output are ta... arm a and b arms. When the E fie... between points 1 and 2, point 1 be... and point 2 becomes negative. The ... charge at point 1 induces a negativ... the wall at point 3. The negative ... 2 induces a positive charge at p... causes the field to form 18... main wavegui...