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Email ID — btbte18019 – mahalaxmi@banasthali.in

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Question	1	2	3	4	5	6
write NA for questions not attempted				NA	NA	NA

Signature of the student

mahalaxmi Kumari

① Soln:- Given

$$Z_L = (100 + j100)\Omega$$
$$Z_0 = 50\Omega$$

The normalized load impedance, $\overline{Z}_L = \frac{Z_L}{Z_0} = \frac{100+j100}{50}$

$\therefore \boxed{\overline{Z}_L = 2+j2} \longrightarrow$ Let point A

Now, draw constant SWR circle through point A. We get load admittance, $\boxed{y_L = 0.24 - j0.25}$ at 0.208λ $\rightarrow$ let point B

In admittance domain r_L circles $\rightarrow g_L$ circles and
x_L circles $\longrightarrow b_L$ circles

for matching need to move towards generator a distance d such that y_d has a real part equal to 1.
This condition is satisfied by two points C and D on smith chart, corresponding to the intersections of the SWR circle with the $g_L = 1$ circle.

Now, for point C;

$y_d = 1 + 1.6j$ point C located at 0.179λ

$$d_{(B,C)} = (0.179 - 0.458)\lambda = -0.279\lambda + 0.5\lambda = 0.221\lambda$$

In order to match: $y_{in} = 1$

But $y_{in} = y_d + y_s = 1 + j1.6 + y_s = 1$

$\therefore \boxed{y_s = -j1.6}$

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So, we need a stub with admittance $-j1.6$. The normalized admittance of a short is $-j\infty$ located at point E.

starting from E, we move towards generator until $y = -j1.6 \rightarrow$ point F (0.34λ).

Distance E-F gives stub length; $l = 0.34\lambda - 0.25\lambda = 0.09\lambda$

<u>for point D;</u>

$y_d = 1 - j1.6$ point D located at 0.322λ

$d(B,D) = (0.322 - 0.458)\lambda = -0.136\lambda + 0.5\lambda = 0.364\lambda$

In order to match; $y_{in} = 1$

The needed normalized input admittance of the stub is

$y_s = j1.6$, located at point G (0.16λ)

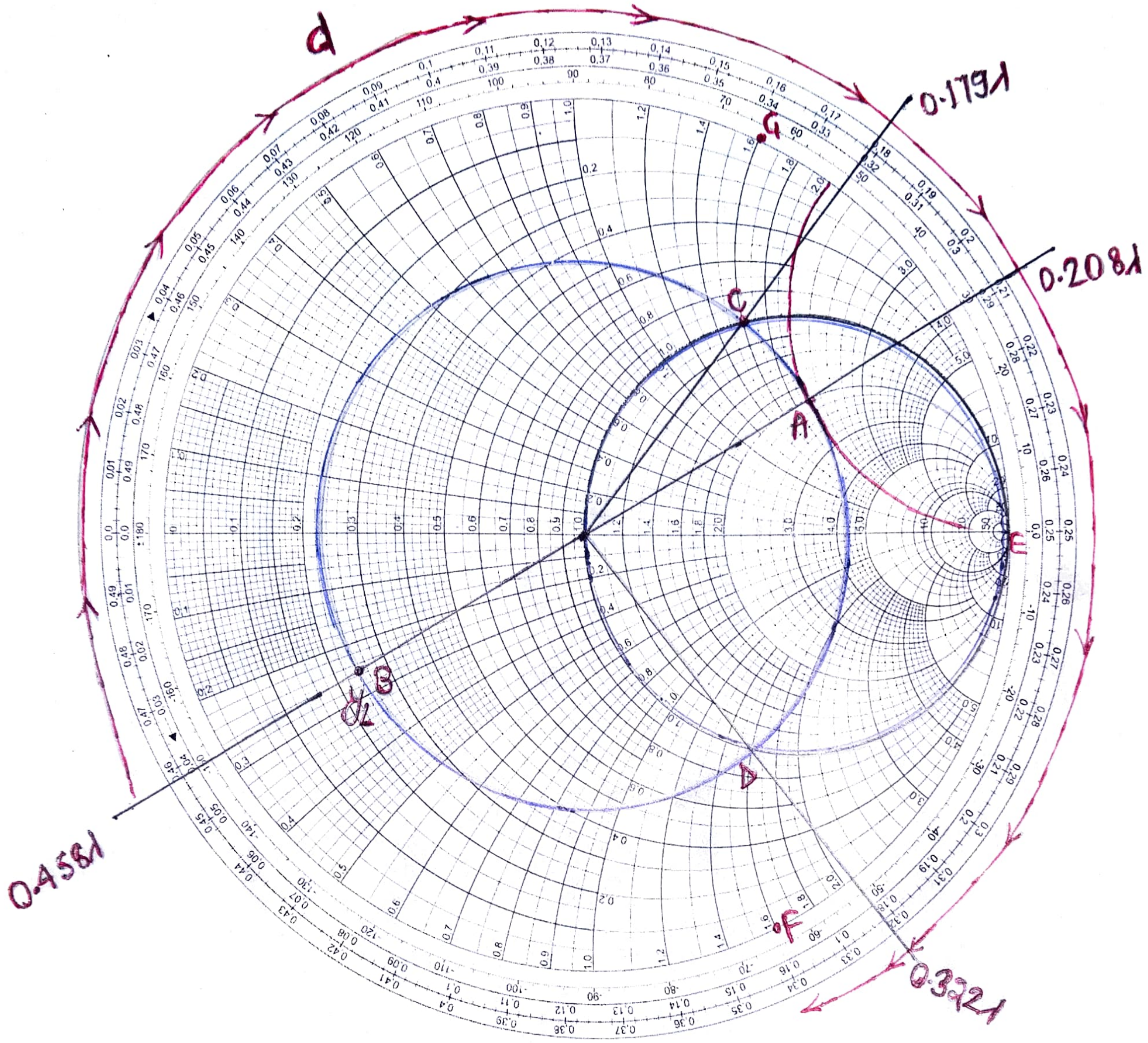
The normalized admittance of a short is $-j\infty$ located at point E.

starting from E, we move towards generator until, $y = j1.6 \rightarrow$ point G (0.16λ)

Distance E-G gives stub length;

$l = 0.25\lambda + 0.16\lambda$

$\therefore l = 0.41\lambda$



Smith Chart

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② Ans:- **Basic operating mechanism of TRAPATT diode**

TRAPATT diode ⟶ derived from the Trapped plasma Avalanche Triggered Transit mode device.

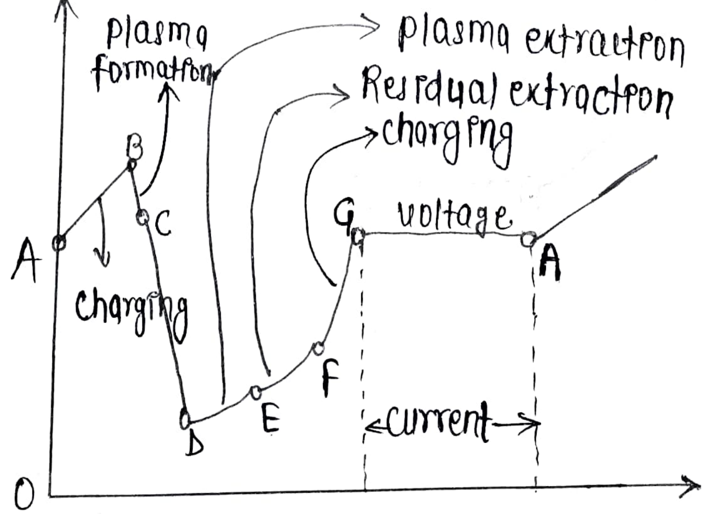
Basics of TRAPATT diode:-

- frequency of operation 1 to 3KHz.
- Noise figure 60dB.
- It works with low power dissipation.
- It works based on plasma Avalanche trigger.
- It has DC to RF efficiency between 0.8 to 60%.
- It is available with p^+-n-n^+ or n^+-p-p^+.
- Trapatt diode provides higher efficiency than IMPATT diode but it has higher level noise figure.

Principle of operation:-

A high field avalanche zone propagates through the diode and fills the depletion layer with a dense plasma of electrons and holes that become trapped in the low field region behind the zone.

The basic operation of the oscillator is a semiconductor p-n junction diode reversed biased to current densities well in excess of those encountered in normal avalanche operation.



At point A electric field is uniform throughout the sample but less than avalanche breakdown. Diode charge like a linear capacitor.

When magnitude of electric field increases above the breakdown voltage, then sufficient number of charge carrier is generated, the particle current (Ip) exceeds the external current (Ie), and the electric field is depressed throughout the depletion region, causing the voltage to decrease. B to C a dense plasma of electron and hole is generated.

At point C to D some of the electrons and holes drift out of the ends of the depletion layer the field is further depressed and traps the remaining plasma.

A long time is required to remove the plasma as shown in graph from D to E.

At point E the plasma is removed, but residual charge of electron in one end of the depletion region and residual charge of holes in other ends.

At point F all the charges that was generated has been removed. The point F to G the diode charges like capacitor.

At point G diode current goes to zero for half a period and the voltage remains constant at Vs until the current comes back on and the cycle repeats.

The TRPATT mode can operate at low frequencies since discharge time of plasma can be considerably greater than the nominal transit time of the diode at high field.

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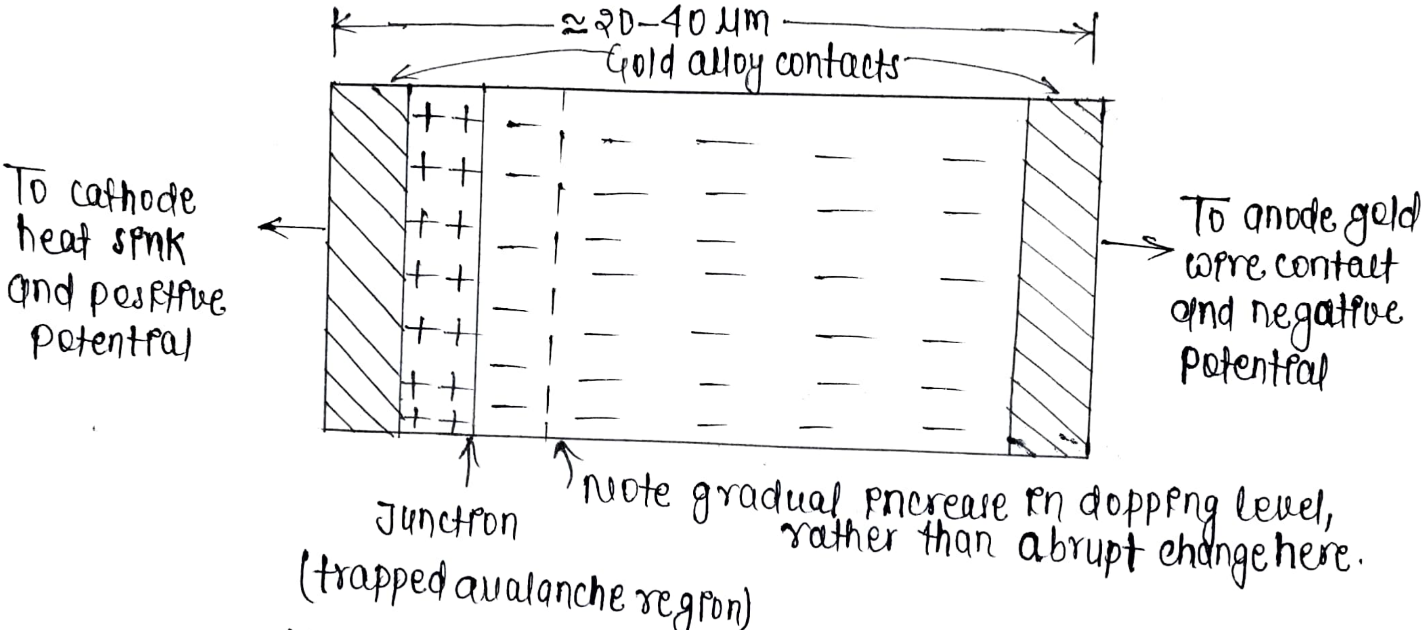

fig:– TRAPATT diode schematic

Consider an IMPATT diode mounted in a coaxial cavity, so arranged that there is a short circuit a half-wavelength away from the diode at the IMPATT operating frequency. when oscillations begin, most of the power will be reflected across the diode, and thus the RF field across the diode will be many times the normal value for IMPATT operation. This will rapidly cause the total voltage across the diode to rise well above the breakdown threshold value used in IMPATT operation. As avalanche now takes place, a plasma of electrons and holes is generated, placing a large potential across the junction, which opposes the applied dc voltage. The total voltage is thereby reduced, and the current pulse is trapped behind it. When this pulse travels across the n+ drift region of the semiconductor chip, the voltage across it is thus much lower than in IMPATT operation. This has two effects. The first is much slower drift velocity, so that for a given thickness the operating frequency is several times lower than for corresponding IMPATT operation. The second point of great interest is that, when the current pulse does arrive at the cathode, the diode voltage is much lower than in an IMPATT diode.

Hence, drift through TRAPATT diode much slower than through a comparable IMPATT diode.

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③ Ans:- The travelling wave tube (TWT) is of the type in which an electron beam passes firstly through a hole in the anode and then through the centre of a cloverleaf slow wave structure, before striking the collector.

Amplification takes place in TWT due to the interaction between the beam and the fields associated with the structure, which has input and output waveguide windows at its ends and is at earth potential.

The RF signal, however, propagates at the speed of light and there must be a mechanism to slow down its speed to permit interaction between the beam and the signal. This slowdown is achieved by using a slow wave structure, which is usually a helix, and the slowed down RF signal is called slow wave. The attenuator isolates the input and output sections to prevent oscillations. The velocity of the electron beam, travelling through the helix, induces/adds energy to the RF waves on the helix, thus amplifying the signal.

Beam wave interaction in TWT device

The helix TWT consists of a cathode, a collector, and a helix that allows the RF to interact with the electron beam.

When the electron enters the helix tube, an interaction takes place between moving axial electric field and moving electrons. The electrons entering the retarding field are decelerated and those in accelerating field are accelerated. They begin forming a bunch centered around about those electrons that enters the helix during the zero field.

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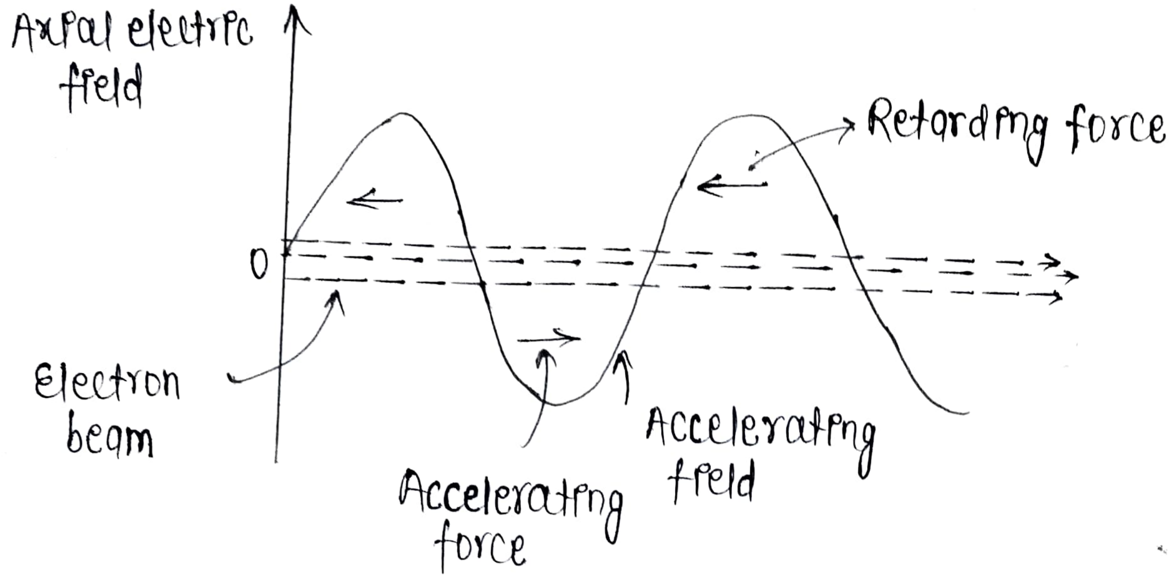

fig:- Interaction between electron beam | beam wave and electric field.

Use of slow wave structure in TWT

Basically the RF wave applied at the input of TWT propagates with the speed of light. while the propagating velocity of the electron beam inside the tube is comparatively smaller than the velocity of RF wave.

If we try to somehow accelerate the velocity of the electron beam, then it can be accelerated only fraction of velocity of light. so it is better to reduce the velocity of the applied RF input in order to match the velocity of the electron beam. Therefore, a slow-wave structure is used that causes a reduction in the phase velocity of the RF wave inside the TWT.

OR,

slow wave structures are special circuits that are used in microwave tubes to reduce wave velocity in a certain direction so that the electron beam and the signal wave can interact. In TWT, since the beam can be accelerated only to velocities that are about a fraction of the velocity of light, slow wave structures are used.