Lecture - 4

Non-linear devices

⇒ Why do we need them?

- To implement complex functions
- For logic operations

⇒  } These are linear

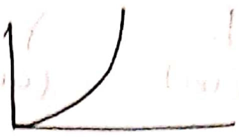
But what if we want to implement a function like this -

$$y = x^2 + 2x + 3yz$$

Then the linear elements won't be enough.

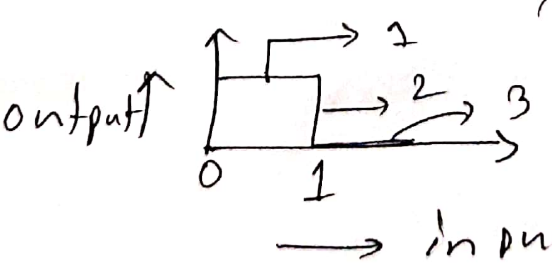
In the non-linear devices the input-output characteristics would be non-linear, for example

or



In a simple NOT gate, the input-output curve is a combination of two or more linear ones.

When the input at node 'A' is 0 (LOW), then the output at 'B' is 1 (HIGH). And when the input is 1, then the output is 0.



more than one line

What about OR / AND operations?

For OR gate —

A (in)	B (in)	Y (out)
0	0	0
0	1	1
1	0	1
1	1	1

For AND —

A (in)	B (in)	Y (out)
0	0	0
0	1	0
1	0	0
1	1	1

You can see, that the outputs here are not exactly linear in nature. We would need several lines to plot these

Now, what is the problem with Non-linear equations?

⇒ Well, they are non-linear.

They are harder to solve.

To Model Non-linear devices, you get Non-linear equations. You need to solve those to design ~~&~~ and analyze the device properly.

Now, for equations like these —

$x+y=2$, $2x+3y=5$ } linear

you can solve these easily.

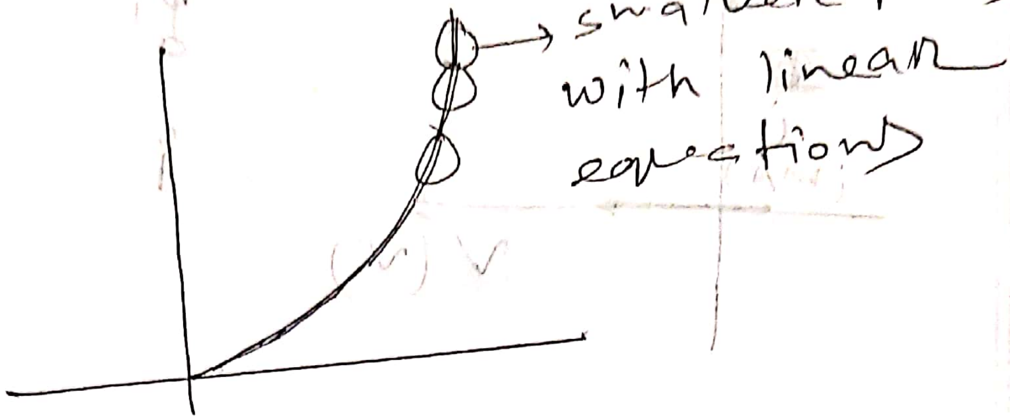
But when you have one like these —

$e^x+y=1$
$x+3xy=5$ } These can't be solved so easily

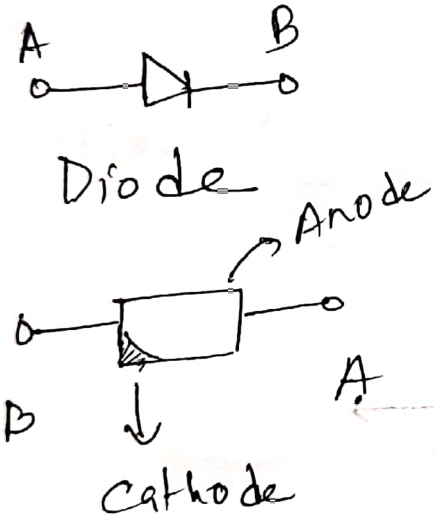
You can plot them and find an intersection point of the two lines (which is the solution). But that would be time consuming and computational load is heavier, if you want to solve is numerically. So what should we do?

→ We $\boxed{\text{divide and conquer!}}$

We just divide the lines into small linear, straight parts and solve the equations for individual parts, which would be a lot simpler!



Piecewise Linear Approximation:



'A' terminal: Anode

'B' terminal: Cathode

Anode voltage : V_A

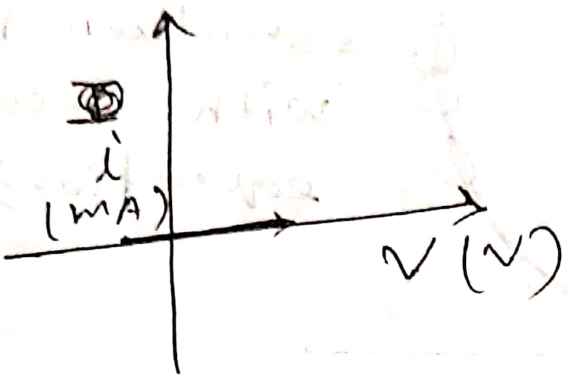
Cathode " : V_B

1) $V_A > V_B$: Forward Bias

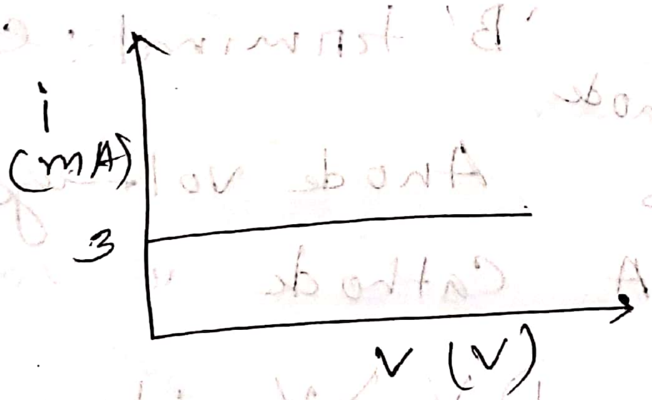
2) $V_A < V_B$: Reverse Bias

Some Basic graphs :

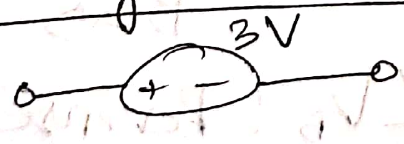
Open circuit :

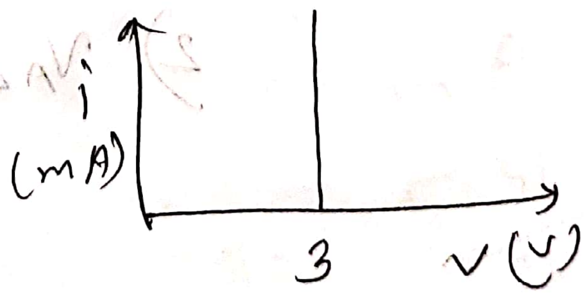


Current source :



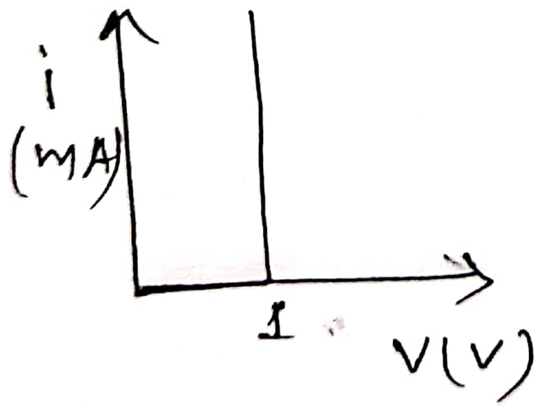
Voltage source





The i-v plot for a Generic non-linear device :

To make calculations easier —



Example 1