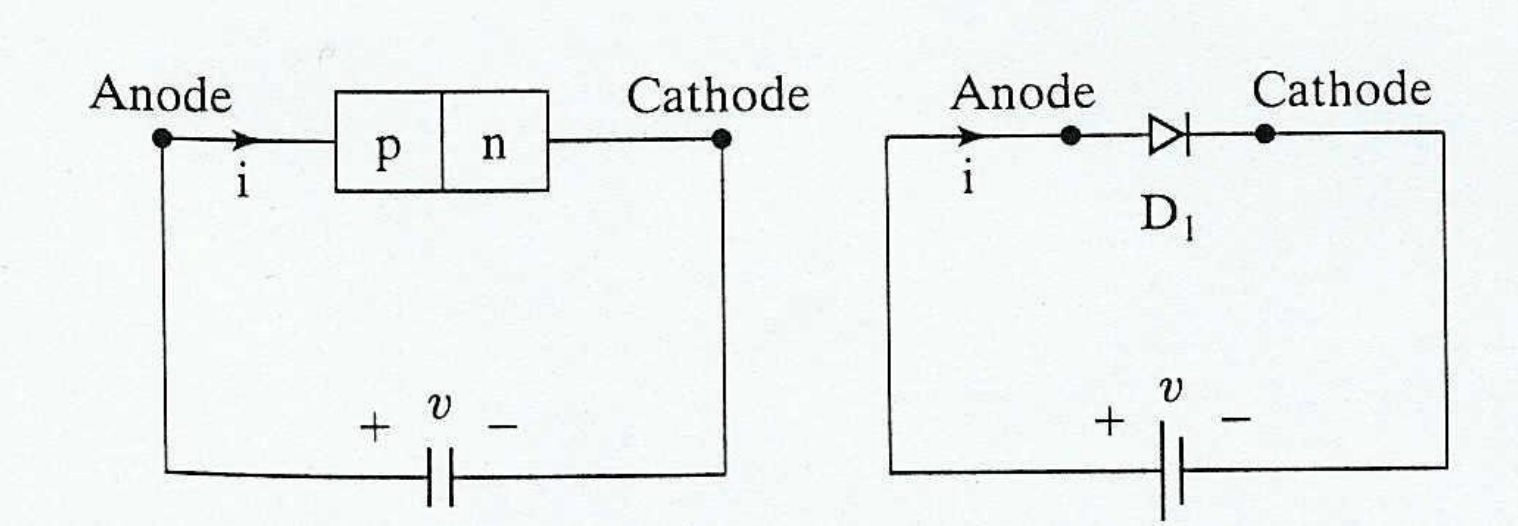
ECE132: Basic Electrical and Electronics EngineeringLab

Experiment 5: VI Characteristics of Diode

PN-Junction Diode Characteristics

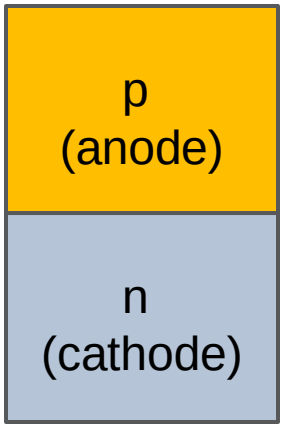


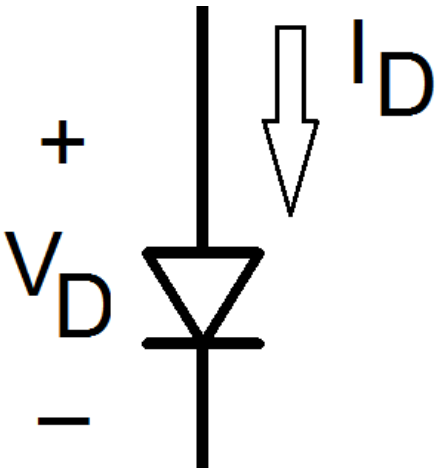
Forward Bias --- External battery makes the Anode more positive than the Cathode --- Current flows in the direction of the arrow in the symbol.

Reverse Bias --- External battery makes the Cathode more positive than the Anode --- A tiny current flows opposite to the arrow in the symbol.

Definition of Diode Current and Voltage

- **Forward Bias**
  - When $I_D > 0mA$ and $V_D > 0V$
- **Reverse Bias**
  - When $I_D < 0mA$ and $V_D < 0V$





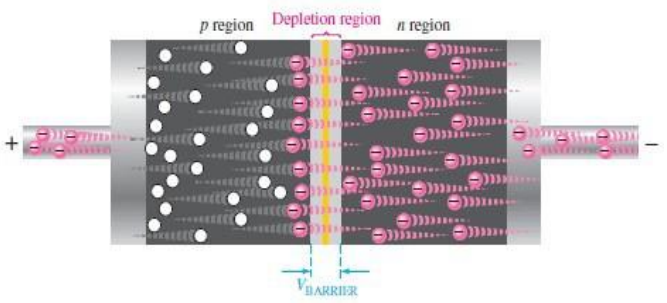
Forward Biased

Forward bias is a condition that allows current through pn junction.

A dc voltage (V_{bais}) is applied to bias a diode.

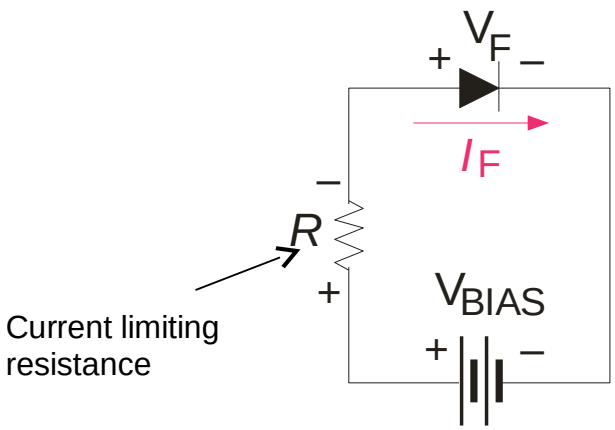
Positive side is connected to p-region (anode) and negative side is connected with n-region.

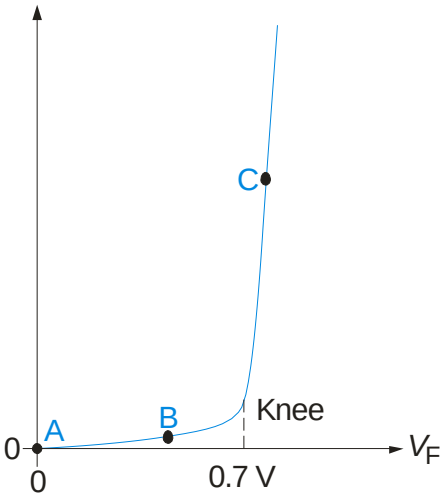
V_{bais} must be greater than 'barrier potential'



As more electrons flow into the depletion region reducing the number of positive ions and similarly more holes move in reducing the positive ions.

This reduces the width of depletion region.

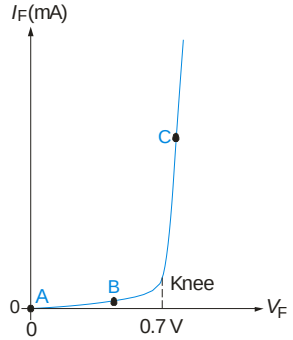


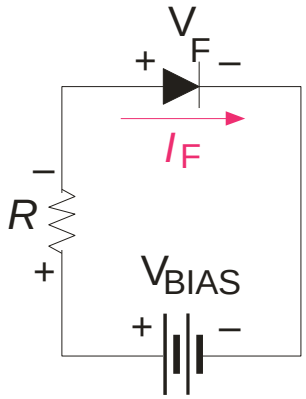


Diode V-I Characteristic

VI Characteristic for forward bias.

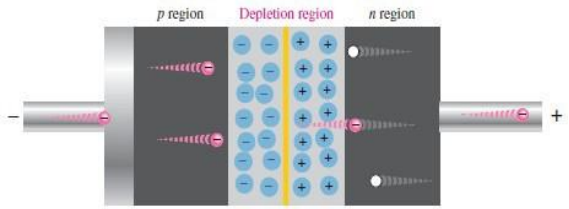
- The current in forward biased called *forward current* and is designated I_f.
- At V (V_{bias}) across the diode, there is no forward current. With gradual increase of V_{bias}, the forward voltage and forward current increases.
- A resistor in series will limit the forward current in order to protect the diode from overheating and permanent damage.
- Continuing increase of V_f causes rapid increase of forward current but only a gradual increase in voltage across diode





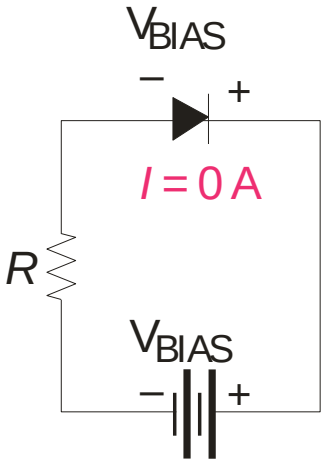
Reverse Biased

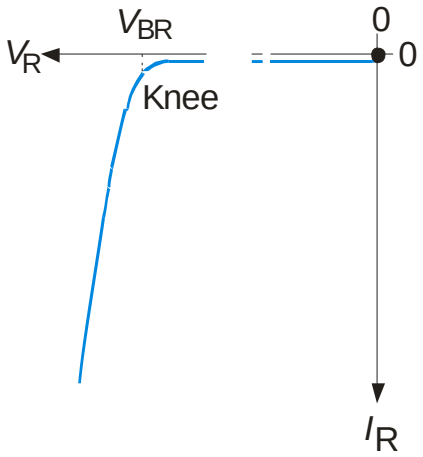
- Reverse bias is a condition that prevents current through junction.
- Positive side of V_{bias} is connected to the n- region whereas the negative side is connected with p-region.
- Depletion region get wider with this configuration.



The positive side of bias voltage attracts the majority carriers of n-type creating more positive ions at the junction.

This widens the depletion region.

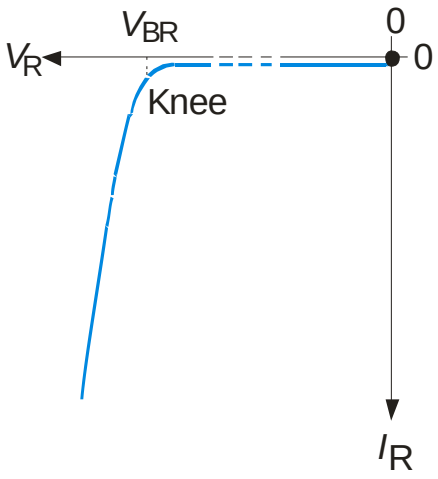




Diode V-I Characteristic

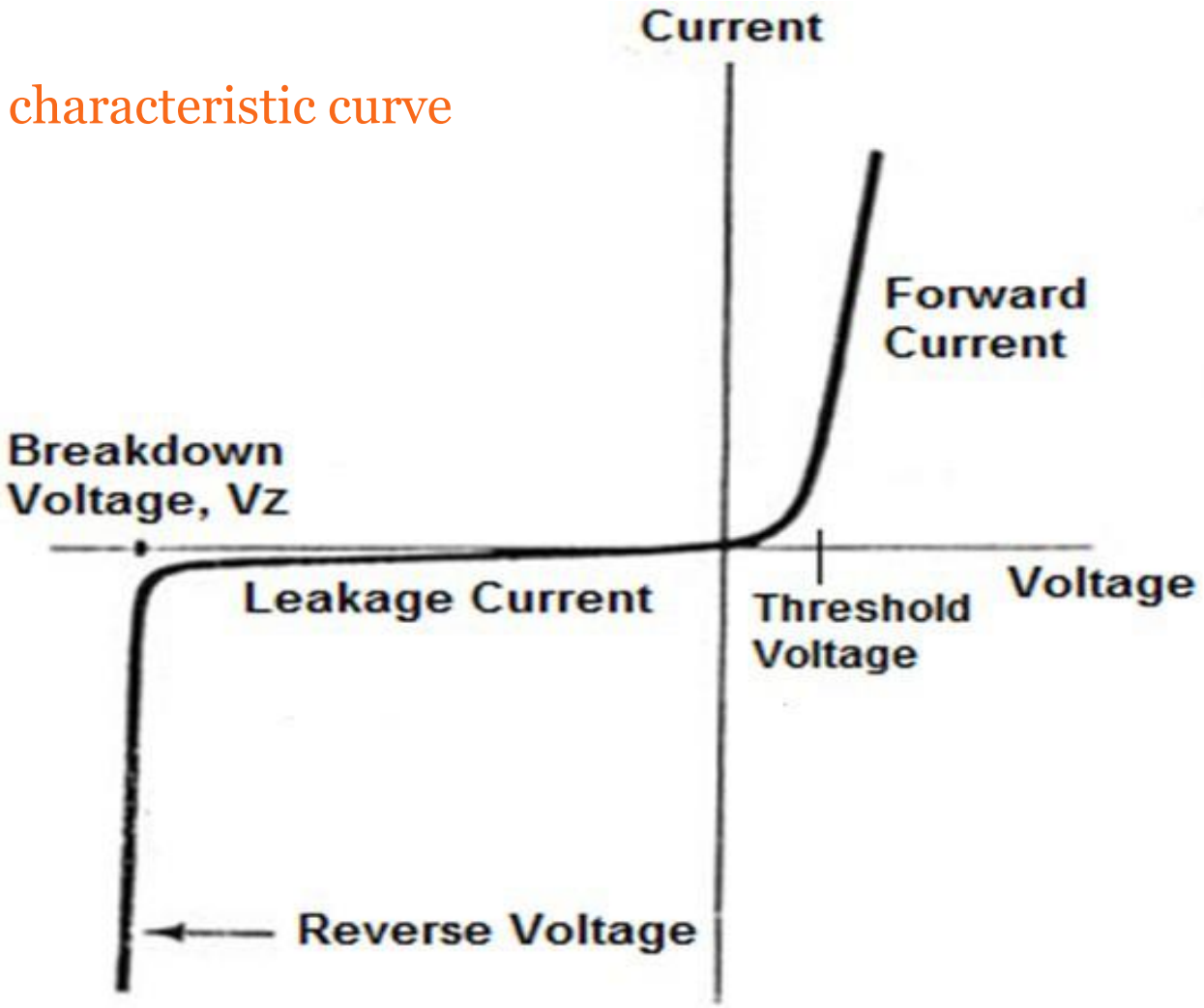
VI Characteristic for reverse bias.

- With oV reverse voltage there is no reverse current.
- There is only a small current through the junction as the reverse voltage increases.
- At a point, reverse current shoots up with the break down of diode. The voltage called break down voltage. This is not normal mode of operation.
- After this point the reverse voltage remains at approximately VBR but IR increase very rapidly.
- Break down voltage depends on doping level, set by manufacturer.



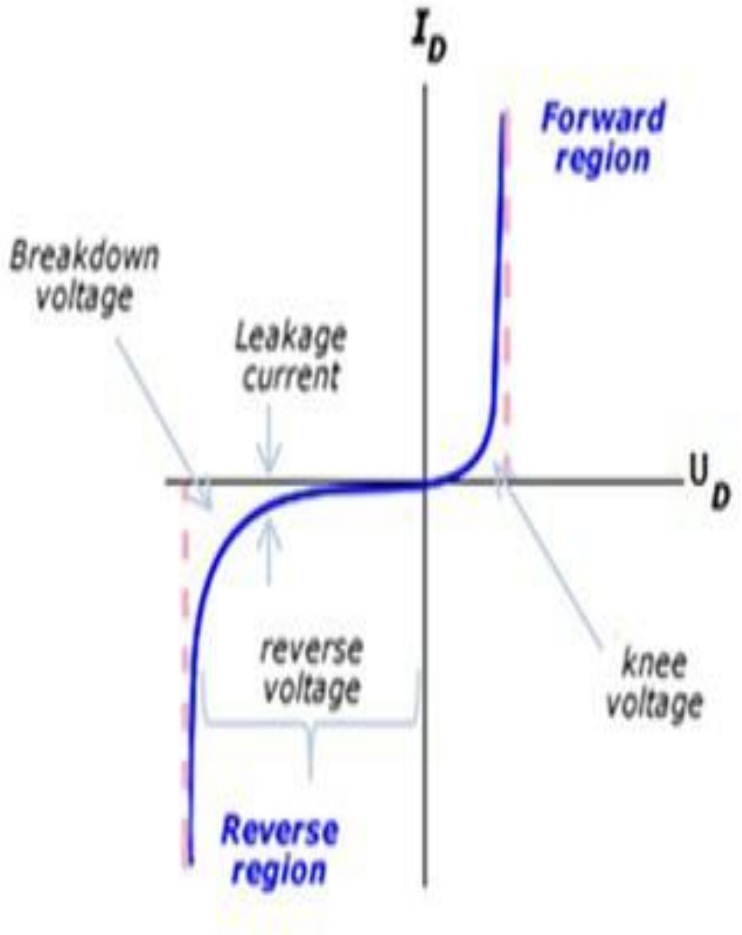
Diode V-I Characteristic

The complete V-I characteristic curve



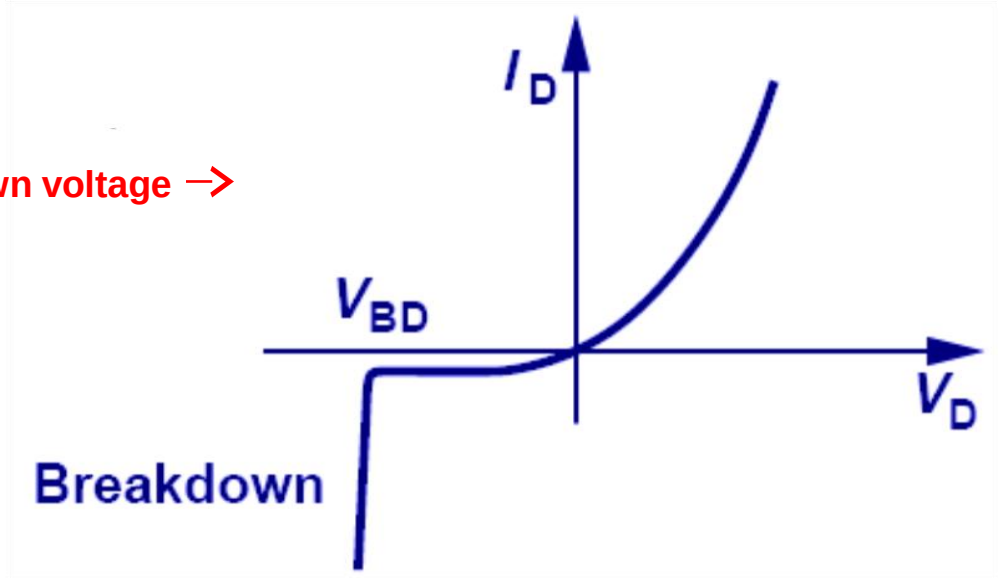
Knee voltage

- The minimum amount of voltage required for conducting the diode is known as “knee voltage” or “threshold voltage” , “cut-in-voltage".
- The forward voltage at which the **current** through PN junction **starts increasing rapidly is known as knee voltage.**
- Knee voltage of **“germanium”** diode is-0.3volts
- Knee voltage of **“silicon"** diode is -0.7volts

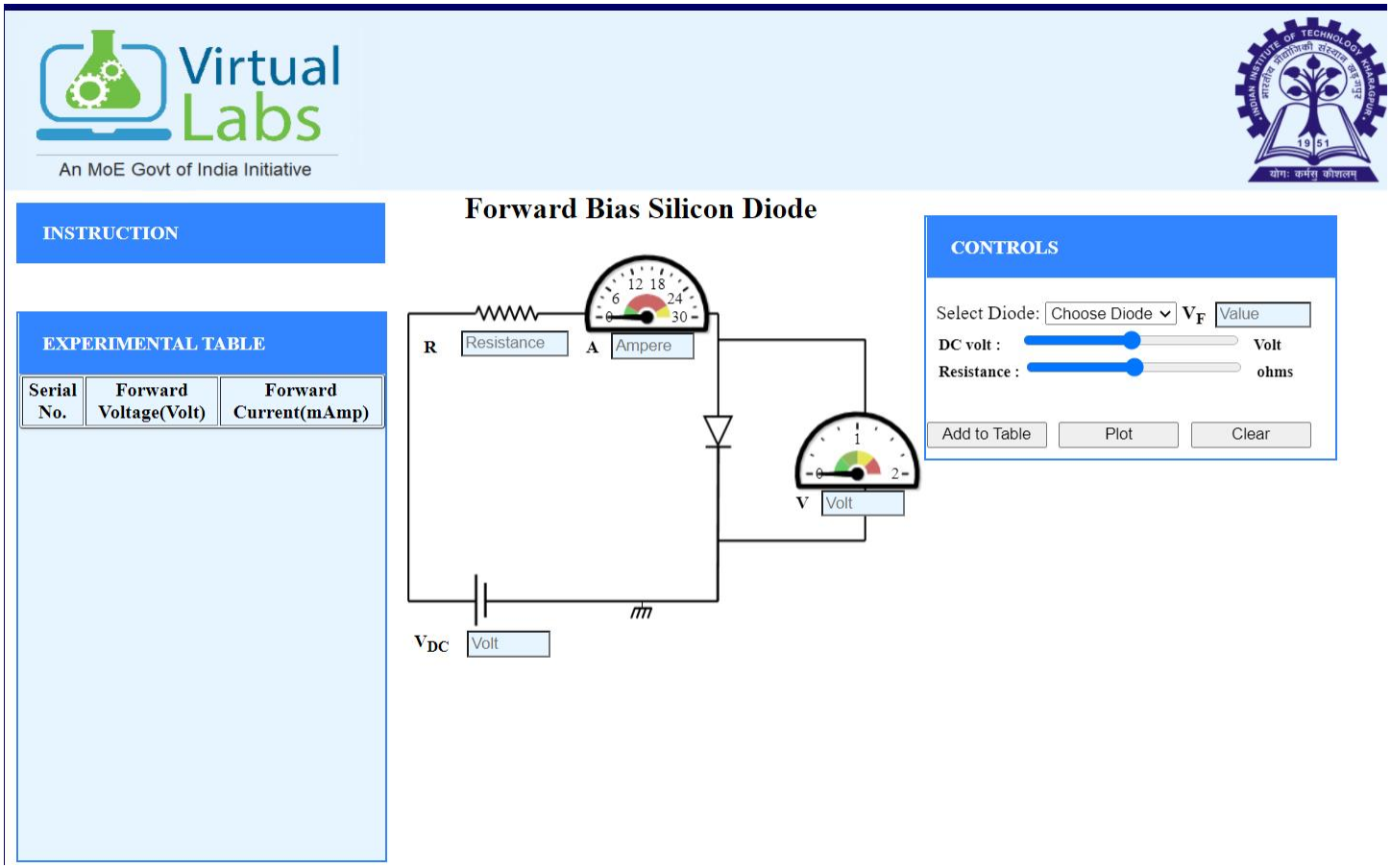


Reverse Breakdown

- As the reverse bias voltage increases, the electric field in the depletion region increases. Eventually, it can become large enough to cause the junction to break down so that a large reverse current flows:



Let plot that on Virtual Lab



Thank you