Types of Diode Breakdown, Diode Approximations

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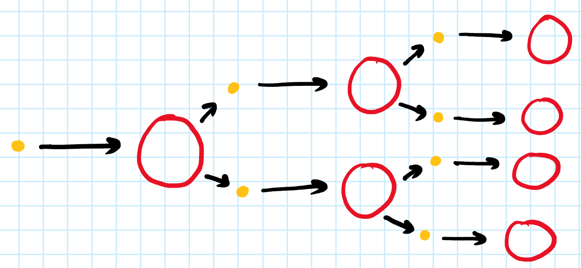
TYPES OF DIODE BREAKDOWN

Avalanche breakdown

Under reverse bias,

Voltage increases → Depletion region widens → Accumulation of more immobile ions → Electric field is generated → Kinetic energy is provided to charge carriers → Collision with other atomic structures → Releases more charge carriers; covalent bonds broken, electron-hole generating

- Happens due to impact ionisation / avalanche multiplication ?

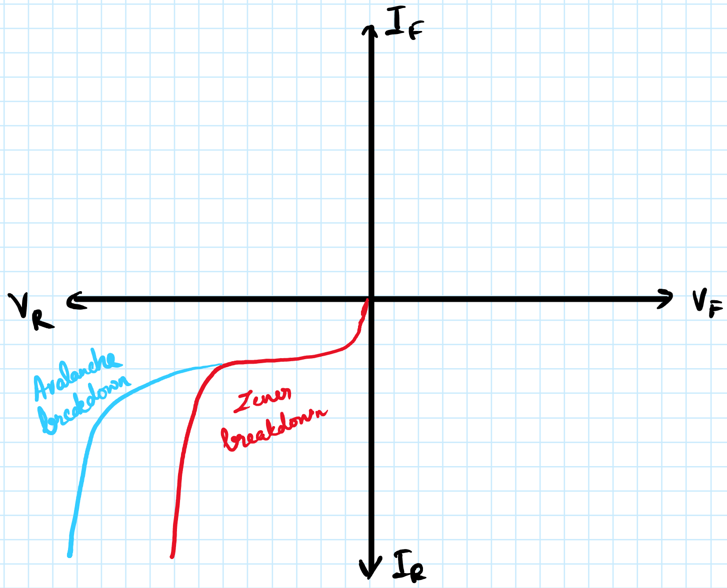


- Motion of these charge carriers creates a sudden jump in current, often damaging the diode itself

Zener Breakdown

- Occurs in Zener diode → Both p and n heavily doped
- Due to more charge carriers, depletion region becomes narrow
- Smaller reverse bias voltage → stronger electric field → more charge carriers liberated

breakdown occurs for a lower voltage



Diode Approximations / Equivalent Diagrams

Mathematical method to approximate non-linear behaviour of real diodes

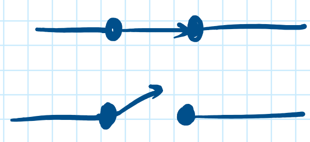
three types

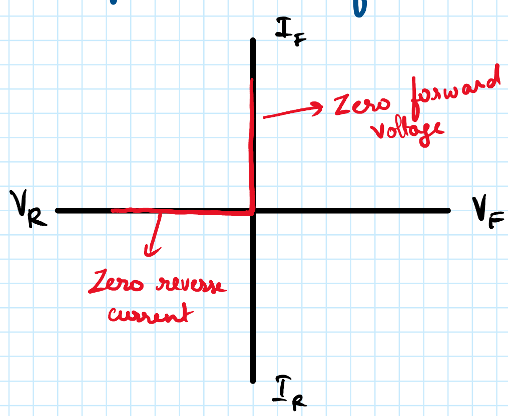
- First Approximation (Ideal Diode Characteristics)
- Second Approximation (Simplified Diode Characteristics)
- Third Approximation (Linear Piece-wise Diode Characteristics)

First Approximation (Ideal Diode Characteristics)

Forward Bias: Closed switch, no voltage drop

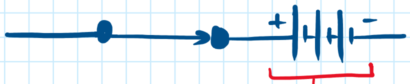
Reverse Bias: Open switch, infinite resistance





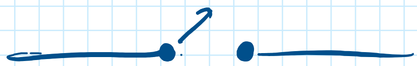
Second Approximation (Simplified Diode Characteristics)

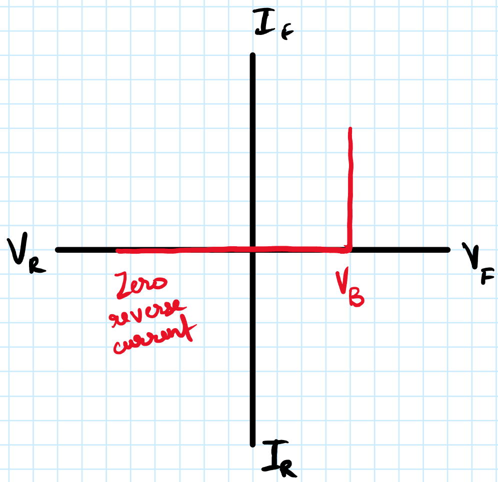
FORWARD BIAS: In series with a battery to turn on, specific knee voltage is given



↳ 0.7 V or greater for Si

REVERSE BIAS: Open switch



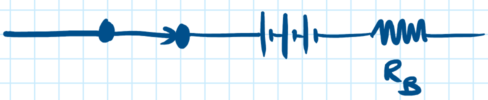


Third Approximation (Linear Piece-wise Diode Characteristics)

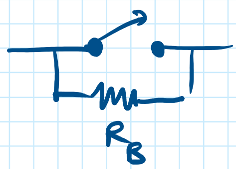
FORWARD: Includes knee voltage as well as voltage across bulk resistance R_B

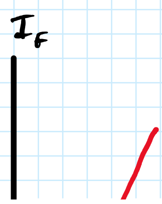
Voltage drop V_D

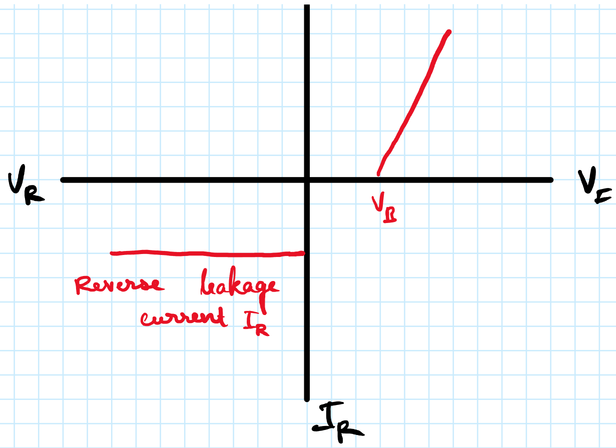
$$\boxed{V_D = 0.7\,V + (I_D)(R_B)}$$



REVERSE: Open switch with R_B in parallel







V_R
V_F
V_B
Reverse leakage current I_R
I_R