Unit 7: Semiconductor Diodes

Monday, 7 April 2025 12:10

Pure Silicone conducts electricity
↳ But not very well

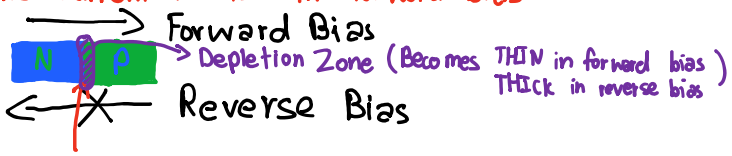
Many types of Semi Conductors
↳ Silicon (Most common)
↳ Germanium
↳ Gallium-Based

Silicon can be doped 2 ways
↳ P-Type } Both conduct
↳ N-Type } Better than pure silicon

P-Type (Has 'Holes')
↳ Doped with impurities such that it has an ABSENCE of electrons

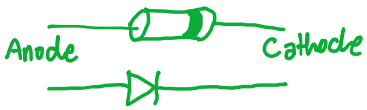
N-Type (Has 'Extra')
↳ Doped with impurities such that it has EXTRA electrons

Diodes
↳ Block current in reverse bias
↳ Allows current to flow in forward bias

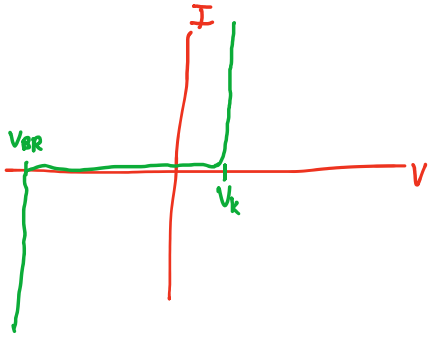


Junction is known as PN Junction

↳ Properties of Diodes



↳ Diode Voltage (V_d)
  ↳ Voltage across Diode
↳ Forward Voltage (V_F)
  ↳ Voltage across Diode WHEN in Forward Bias!
↳ Knee Voltage (V_k)
  ↳ Minimum Forward Voltage required to allow current to flow easily
↳ Breakdown Voltage (V_{BR})
  ↳ Reverse Voltage when an Avalanche Current will flow, in reverse Bias

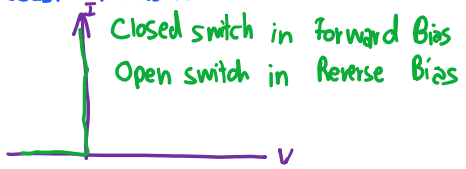


Ideal and Simplified Diode Model
↳ Practical Diode Model using Above Characteristic Graph

↳ Most Accurate

→ Ideal Diode Model uses simple Characteristic Graph

↳ Least Accurate

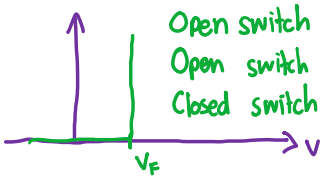


Closed switch in Forward Bias

Open switch in Reverse Bias

↳ Simplified Diode Model uses Simplified Characteristic Graph

↳ ≈ Accurate



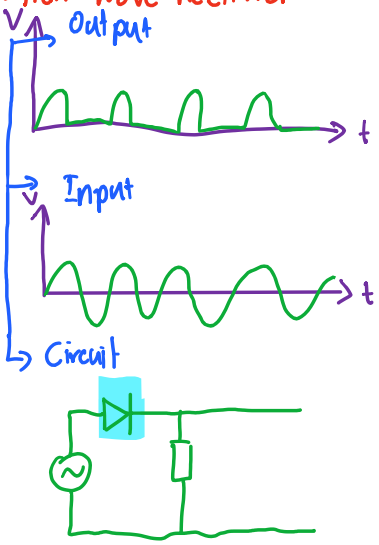
Open switch in Reverse Bias

Open switch in Forward Bias $< V_K$

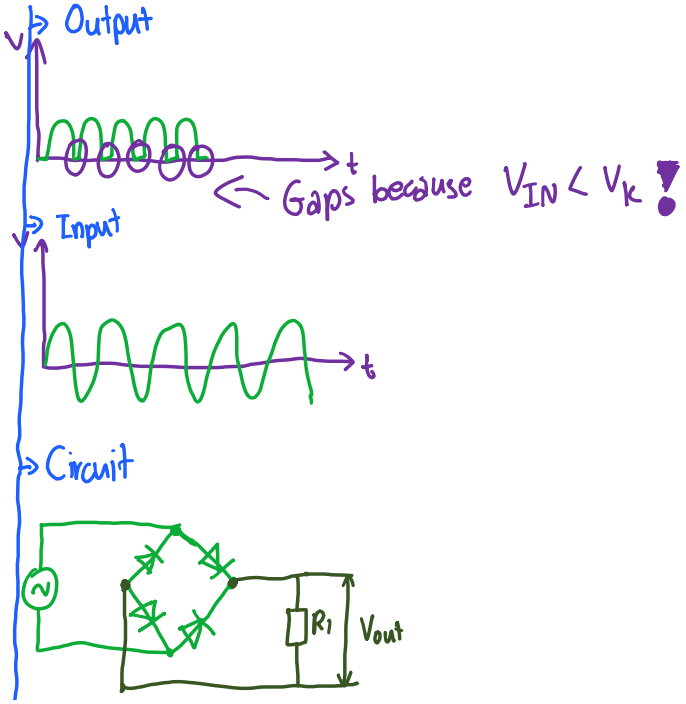
Closed switch with voltage drop of V_F in Forward Bias $\geq V_K$ (Like a Battery in Reverse Bias)

Rectifiers

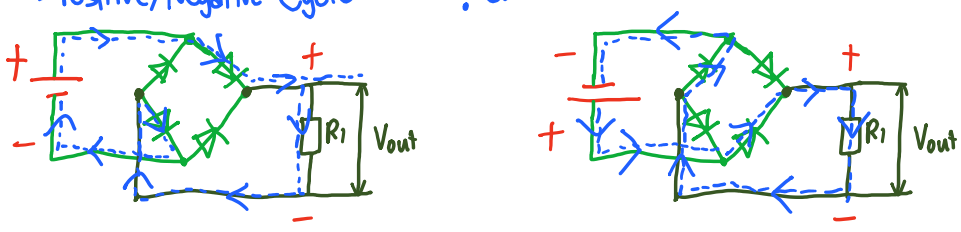
↳ Half-Wave Rectifier



↳ Full-Wave Rectifier



↳ Positive/Negative Cycle ---: Current

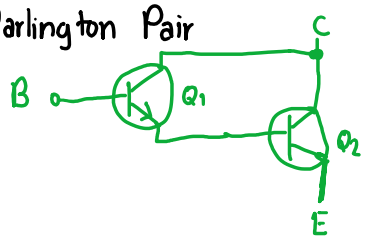


Zener Diodes

↳ Replace breakdown voltage of normal diodes with Zener Voltage
↳ If $V_{IN} \leq V_Z$, V_{OUT} is regulated at V_Z
↳ Usually placed in Reverse Bias
↳ Acts like a normal diode in forward bias
↳ Regulate at V_Z in Reverse Bias

↙ Can be used with a rectifier & Voltage Smoothening Capacitor to regulate a smooth voltage (at V_Z)

Darlington Pair



↳ If I_B is too small to get BJT into saturation region
↳ Q_1 will amplify the signal for Q_2 to work ($\beta_1 \times \beta_2$)
↳ Use when Activation current is very small
↳ Only use when necesary (Disadvantages)
↳ Slower switching speed
↳ Need Higher Voltage (2 Base Activation Voltages required)
↳ Higher voltage drop