Diode: \( I = I_0 \left( e^{\frac{V}{V_T}} - 1 \right) \)

Load Line Analysis

Ideal Diodes:

Piecewise Linear Analysis

Precision Diode Circuits

Using OpAmp can make an ideal diode from a non-ideal diode

Put diode in the feedback loop

Problem: when \( V_{in} < 0 \)
  OpAmp is saturated, Open loop (no feedback since D off)
Improve the circuit by always having feedback.

Try inverting amplifier:

Current can only flow out of opamp:

Feedback when $V_{in} > 0$:

Now opamp sinks all the current when $V_{in} > 0$.
Clipping Circuit

Can cut off any AC signal to fall within a given range

Example: ±12 square → [5, 0] clock
Clamping Circuit

Diode & Capacitor can adjust signal avg.

\[ \text{Vin} \quad \text{Out} \]

\[ RC \gg \Delta t \]

A diode \parallel resistor charges cap very fast.
Rectifiers

Convert AC to DC

\[ \text{Diode} \]

\[ V_{in} \]

\[ R_L \quad V_{out} \]

Smoothing

\[ \text{Capacitor} \]

\[ C \quad R_L \quad V_{out} \]

"Ripple"
Full Bridge Rectifier

Want both halves

Positive half

Negative half

Diagram of the full bridge rectifier with positive and negative half-cycles illustrated.
Zener Diodes

All diodes will break down with large reverse bias.

This might destroy regular diode.

Zener diodes are designed to break down! And designed to do so at very specific voltage.

\[ V_2 = 6 \text{ V} \quad V_{in} = 12 \text{ V} \quad \text{sine wave} \]

\[ R_2 = 3R_1 \]
Zeners Useful For Regulating Voltage!

\[ V_{\text{in}} \rightarrow R \rightarrow V_{\text{out}} \]

\[ V_{\text{in}} = 6V \]

\[ V_{\text{in}} = 8V \]

Voltage Regulators

Fixed 7806 7906
+6V -6V

Basic Idea

\[ V_{\text{in}} \rightarrow \text{op-amp} \rightarrow \text{output} \]
723 Regulator

Variable 2-250 Volts (3-38)

Power limitations

\[ \text{Vout} > V_{\text{Ref}} \]

R1, R2 voltage divider compares

\[ \frac{R_2}{R_1 + R_2} \text{ Vout to } V_{\text{Ref}} \]

R4 to limit current, want \( V_4 \approx 0.5 \text{ V} \)

at max I

R3 for impedance matching (can be short)

\[ R_3 = R_1 / R_2 \]

Vin a few more V pos. than Vref

Vout < V_{\text{Ref}}: \quad R_1, R_2 \text{ between } V_{\text{Ref}} \text{ and } 1\Omega

R3 between \text{Vout} \text{ and } 1\Omega