I. Review nonlinear elements & linearization
II. Review semiconductor basics
III. Diode circuit examples
**NONLINEAR ELEMENTS**

- Analyzing circuits (i.e., solving systems of equations) is difficult if the governing equations are nonlinear
  - This usually refers to an current – voltage (I-V) characteristic
- We like all of our circuit elements to be linear
  - We approximate nonlinear elements as piecewise-linear

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**Resistor**

- $I_R$ vs. $V_R$

**Capacitor**

- $I_C$ vs. $V_C$

**Inductor**

- $I_L$ vs. $V_L$

**Diode**

- $I_D$ vs. $V_D$

**MOSFET**

- $I_D$ vs. $V_{DS}$
**SEMICONDUCTOR TYPES**

**UNDOPED SILICON**

**-TYPE SILICON**

**-TYPE SILICON**
PN Junctions

Diagram showing a pn junction with voltage applied, illustrating the depletion region, bound charges, and free charges. The potential barrier voltage $V_0$ is also shown.
PN JUNCTIONS | NO APPLIED VOLTAGE

OPEN-CIRCUIT PN JUNCTION

CARRIER CONCENTRATIONS

CHARGE DISTRIBUTION

BUILT-IN VOLTAGE, $V_0$
PN JUNCTIONS | WITH APPLIED VOLTAGE

- **Open-Circuit (Equilibrium)**
- **Reverse Bias**
- **Forward Bias**
**Diodes**

**Ideal Diode**

- Anode
- Cathode
- \( v < 0 \Rightarrow i = 0 \)
- \( i > 0 \Rightarrow v = 0 \)

**Constant-Voltage-Drop Model**

- Anode
- Cathode
- \( i > 0, v_D = 0.7 \text{ V} \)

**Actual I-V Curve**

- Reverse bias
- Forward bias

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Assuming the diodes to be ideal, find the values of $I$ & $V$ in the circuit below.
Assuming the diodes to be ideal and the input triangle wave shown, sketch the output waveform.
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