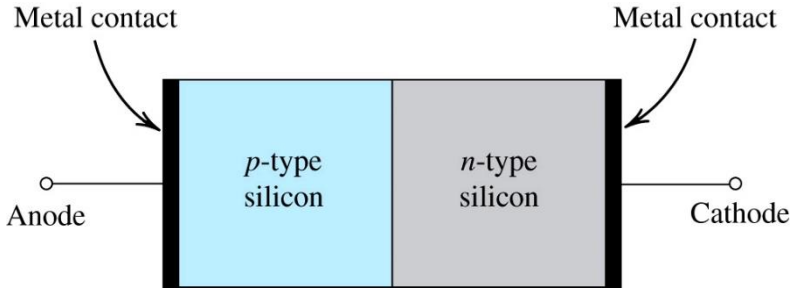
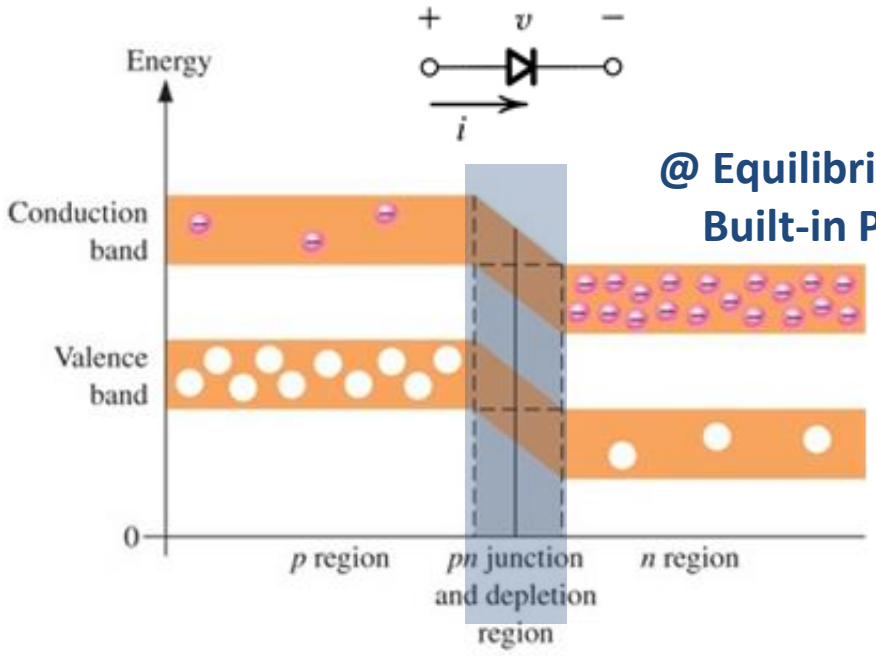
Last Lecture → PN Junction

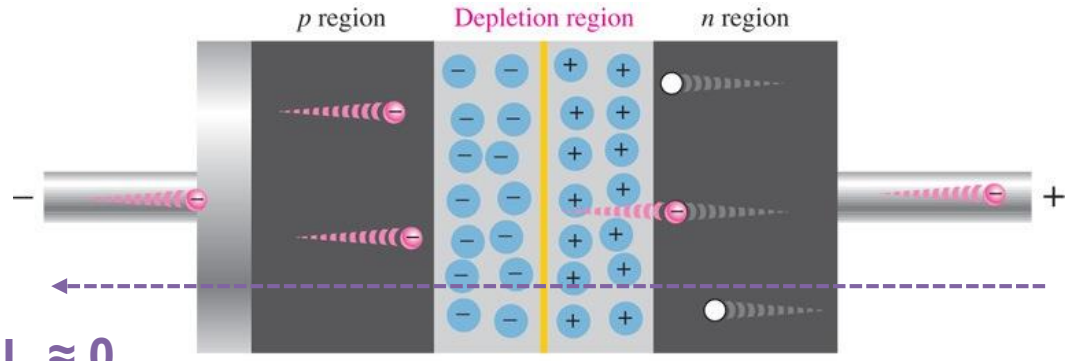
8/23/2019





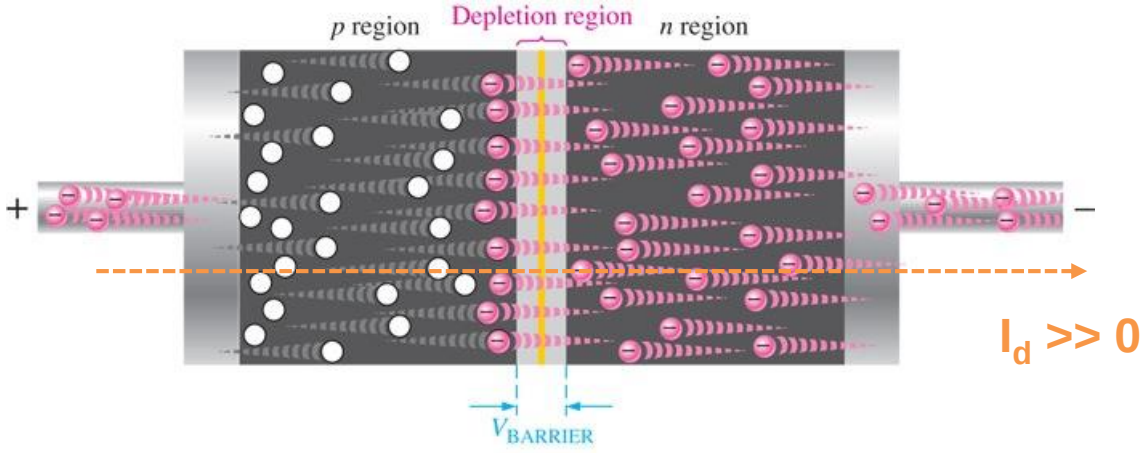
@ Equilibrium
Built-in Potential

- ***Reversed Biased → $v_d < 0$***



$I_d \approx 0$

- ***Forward Biased → $v_d > v_0$***



$I_d >> 0$

Last Lecture → Diode Behavior

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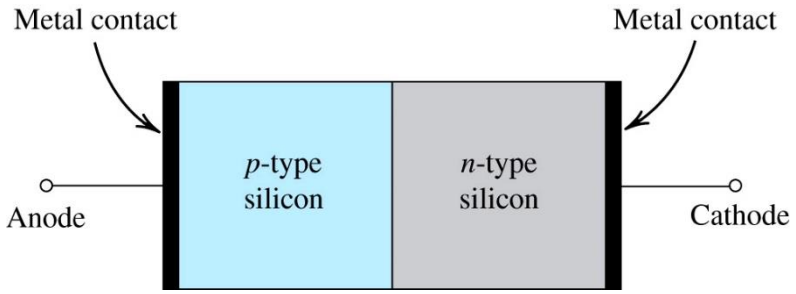

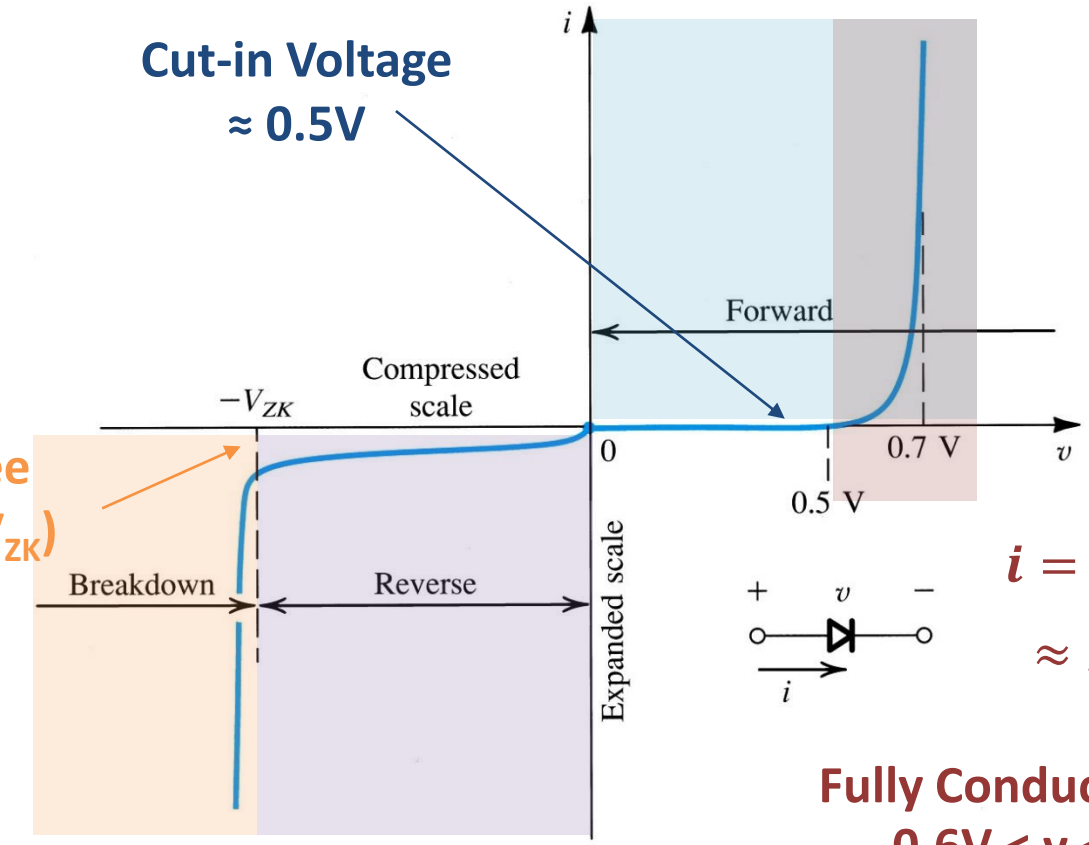

Characteristic Regions

- **Forward Bias: v > 0**
- **On v ≥ 0.5V**
- **Reverse Bias: v < 0**
- **Breakdown: v << 0**

$$i = I_S\left(e^{v/V_T} - 1\right)$$

$$\approx I_S e^{v/V_T}$$

Fully Conducting Region
0.6V < v < 0.8V

$$i = -I_S e^{-|v|/V_T}$$

$$i \approx -I_S$$

- I_S → saturation current
- V_T → thermal voltage

Last Lecture → Exponential Model

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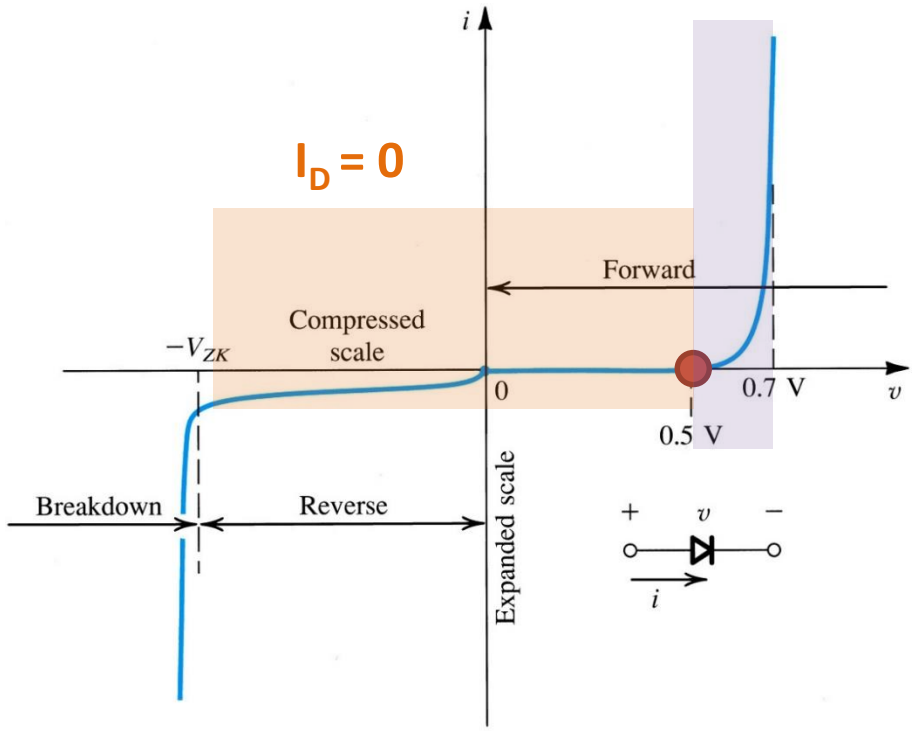
DC Analysis
- Ideal Model
- Constant-Voltage-Drop Model
- Exponential Model
  - Graphical Analysis
  - Numerical Analysis

AC Analysis
- Small Signal Model

Your simulation results are as good as your model!!!!



Exponential Model

$$for\ v < 0.5 \rightarrow I_D \approx 0$$

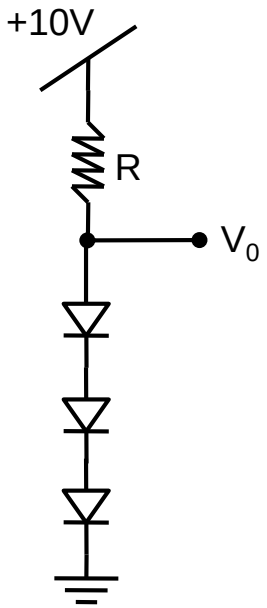
$$for\ v \geq 0.5 \rightarrow I_D \approx I_S e^{v_D/V_T}$$

Problem

Assuming that the diodes available have 0.7V drop at 1mA,

a) design the given circuit to provide an output voltage of 2.4V

b) find the output voltage for R = 642Ω



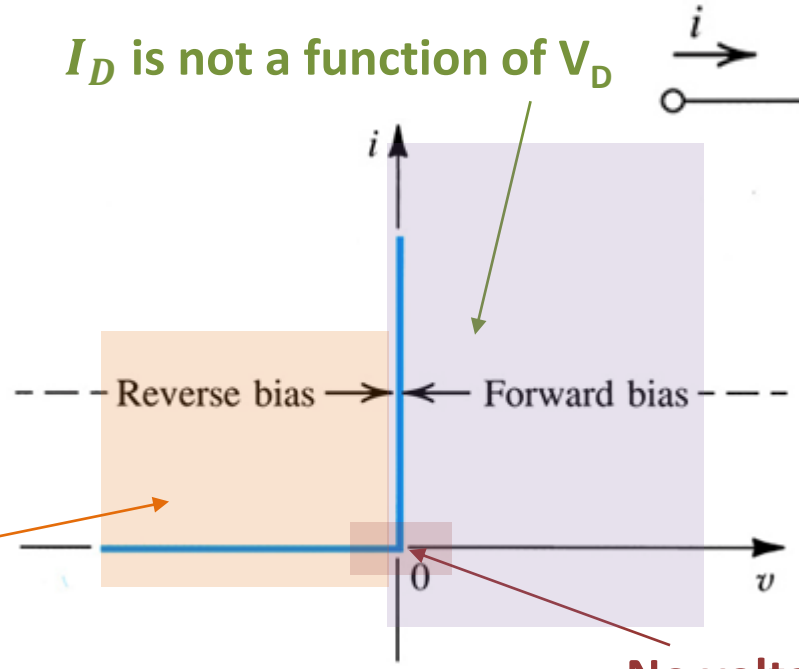
Diode Models

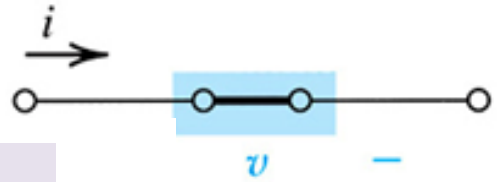
8/23/2019

DC Analysis
- ✓ Ideal Model
- • Constant-Voltage-Drop Model
- ✓ Exponential Model
  - ▪ Graphical Analysis
  - ✓ Numerical Analysis

AC Analysis
- • Small Signal Model

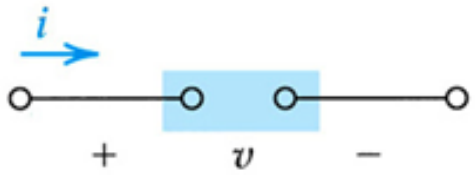
I_D is not a function of V_D





$0 \Rightarrow v = 0$

No reverse current



$v < 0 \Rightarrow i = 0$

No voltage drop when conducting current

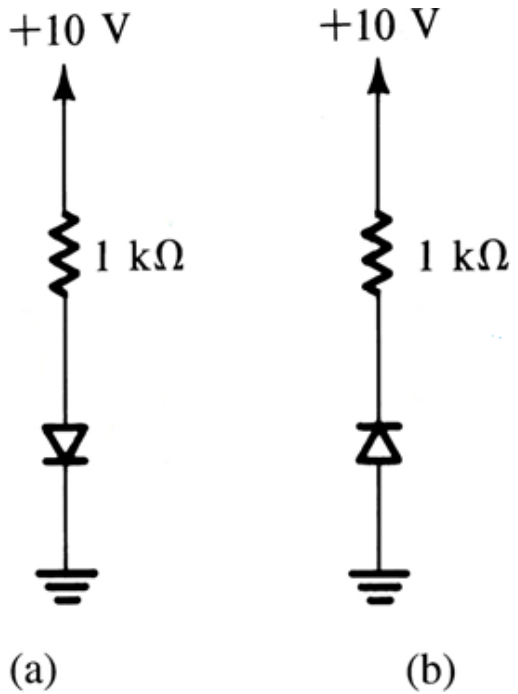
Ideal Model

$for\ v < 0 \rightarrow I_D = 0$

$for\ ID > 0 \rightarrow v = 0$

Solving Circuits with Diodes

1. **Choose a model for the diode**
2. **Make an educated guess of the region of operation of the diode**
3. **Solve the circuit via mesh / nodal analysis**
4. **Verify if the condition of the region of operation are satisfied!**

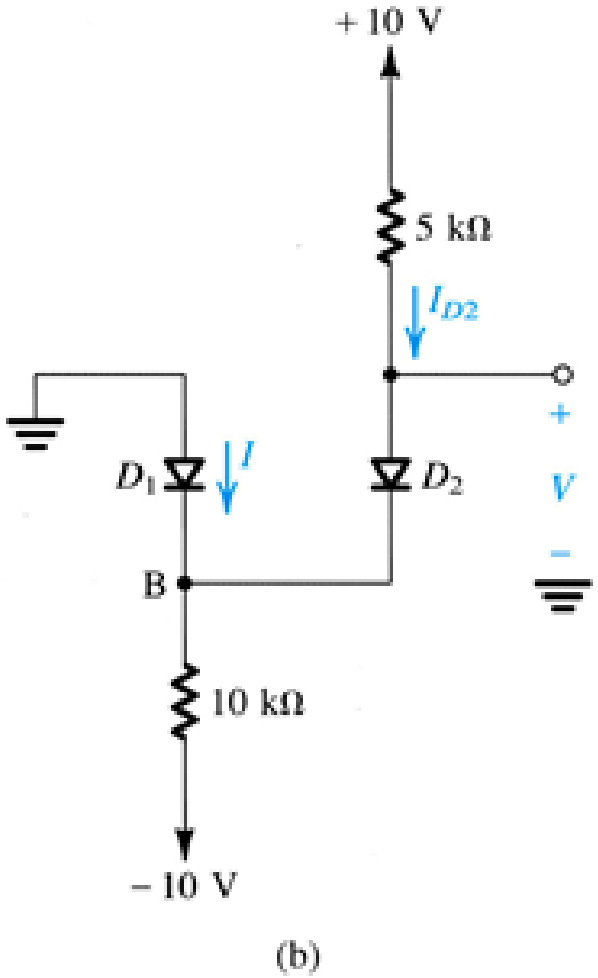


For the given circuits, determine the current flowing through the resistor.

Solving Circuits with Diodes

1. Choose a model for the diode
2. Make an educated guess of the region of operation of the diode
3. Solve the circuit via mesh / nodal analysis
4. Verify if the condition of the region of operation are satisfied!

Example 4.2 - Assuming the diodes to be ideal, find the values of I and V in the given circuits …



(b)