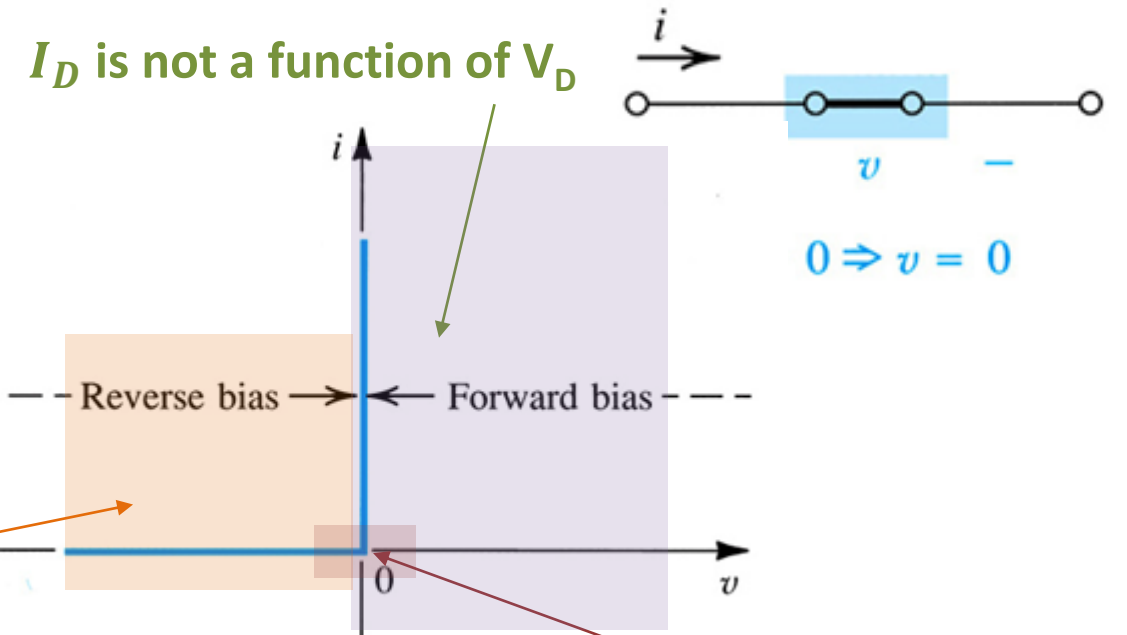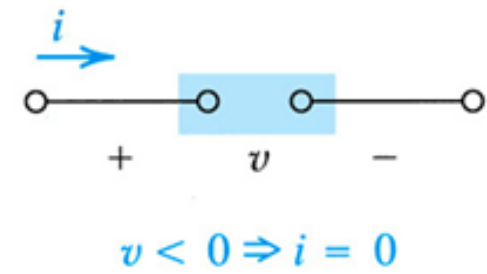# Electronics I

Last Lecture → Ideal Model

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**

$$0 \Rightarrow v = 0$$

Reverse bias → ← Forward bias

No reverse current

No voltage drop when conducting current

Ideal Model

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

$$v < 0 \Rightarrow i = 0$$
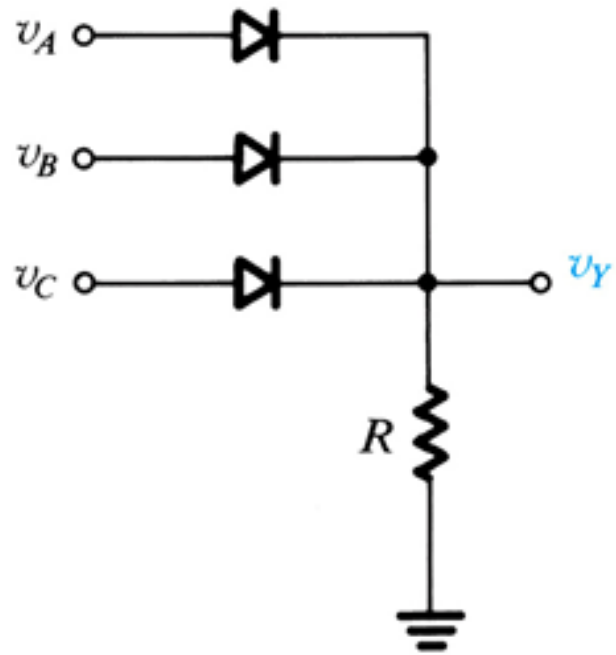
Electronics I

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!**

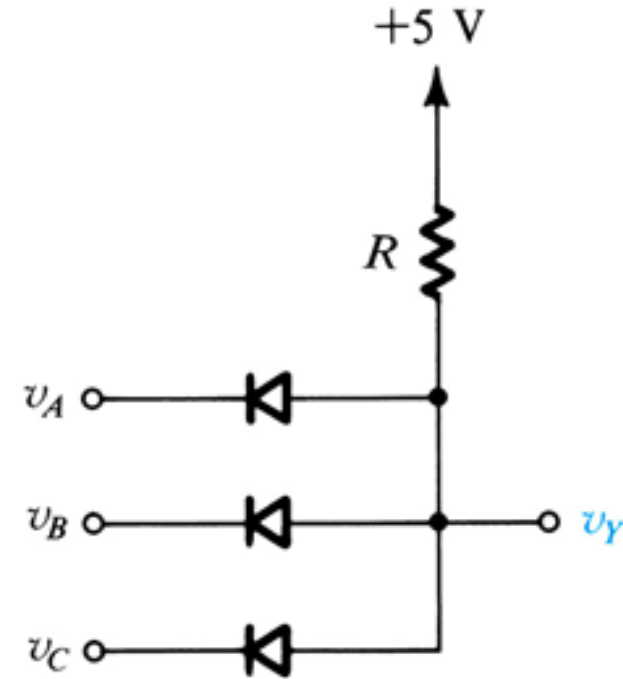**Example 4.2** - Assuming the diodes to be ideal, find the values of I and V in the given circuits ...

Electronics I
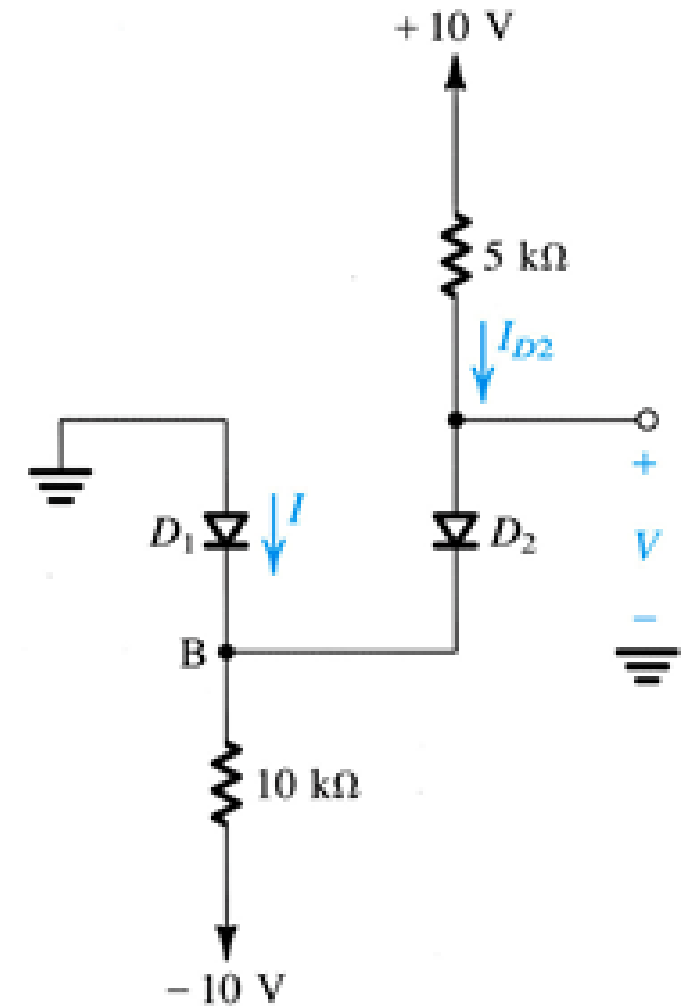
Diode Logic Gates

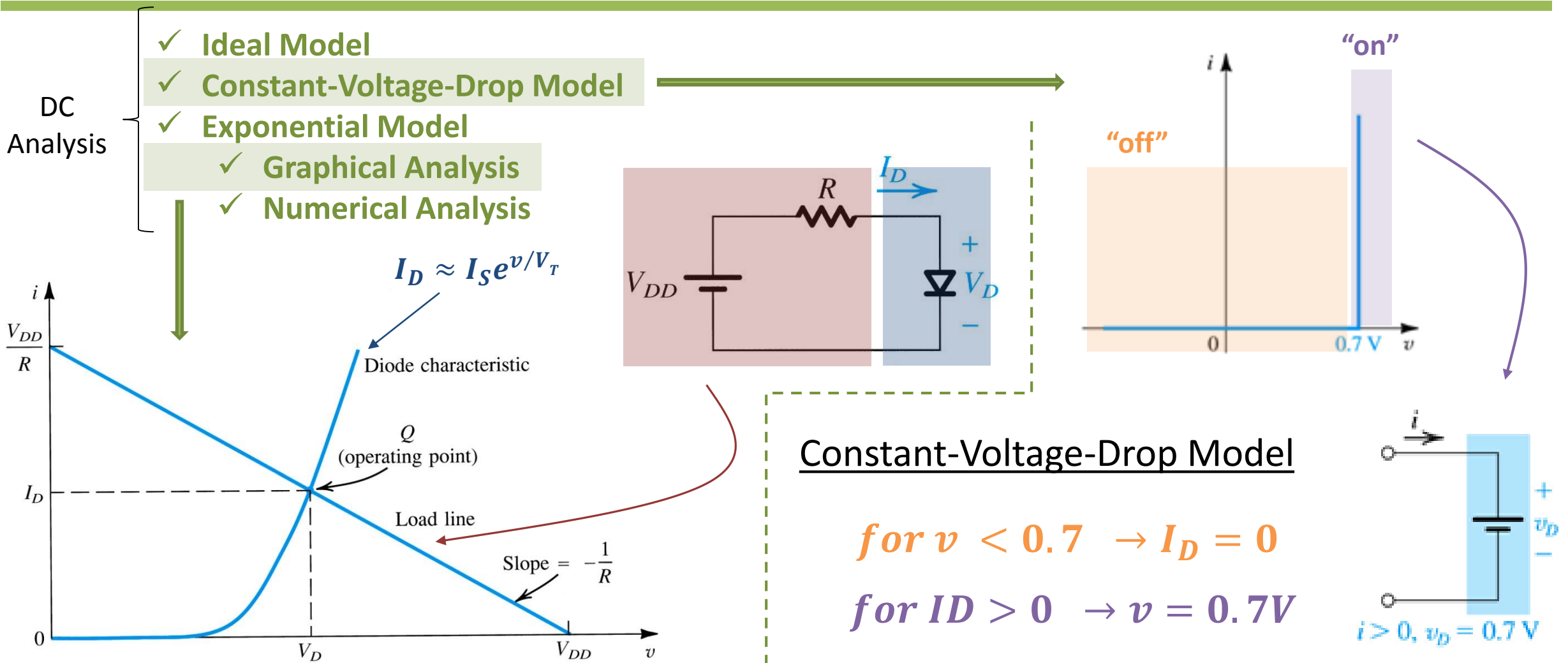**Diodes together with resistors can be used to implement logic functions...**

(a)

(b)

Electronics I

Constant-Voltage-Drop Model

DC
Analysis

- ✓ **Ideal Model**
- ✓ **Constant-Voltage-Drop Model**
- ✓ **Exponential Model**
  - ✓ **Graphical Analysis**
  - ✓ **Numerical Analysis**

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

"off"   "on"

Diode characteristic

Q
(operating point)

Load line

Slope $= -\dfrac{1}{R}$

$\dfrac{V_{DD}}{R}$

I_D

V_D V_{DD}

Constant-Voltage-Drop Model

$$for \ v < 0.7 \ \rightarrow I_D = 0$$

$$for \ ID > 0 \ \rightarrow v = 0.7V$$
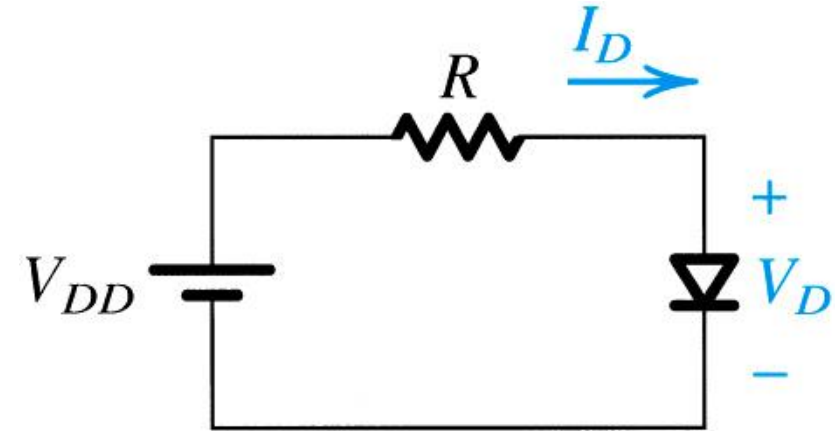
$i > 0, \ v_D = 0.7 \ V$

Diode Models → Comparison

For the given circuit determine I_d using all three models of the diodes. Assume

- V_{DD} = 5V
- R = 1kOhm

Assume

- V_D = 0.7V (constant voltage model)
- I_{DQ} = 1mA @ 0.7V (exponential model)

Model	I_d (mA)
Ideal	5.00
Constant Voltage Drop	4.30
Exponential	4.26

Linear model pretty close to the actual value!

Electronics I

Diode Application → Rectifier

For the given circuit:
1) **Plot v_0 vs v_i**
2) **Plot $v_0(t)$**
3) **Plot $v_d(t)$**