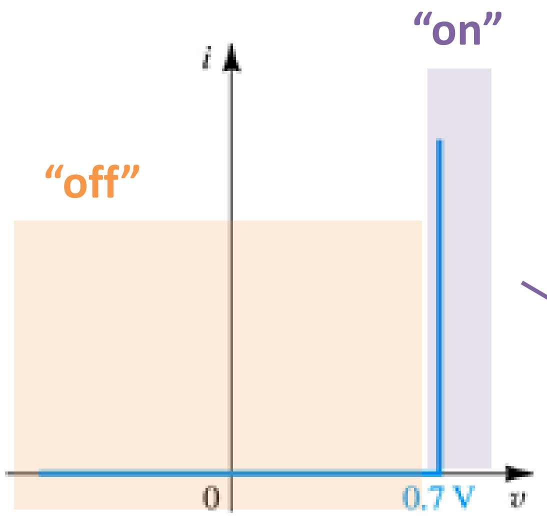
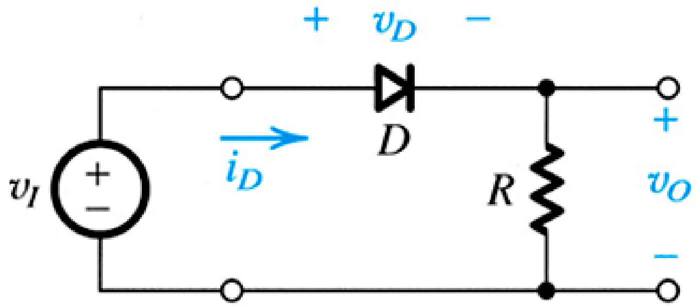
Last Lecture → Constant-Voltage Drop Model

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



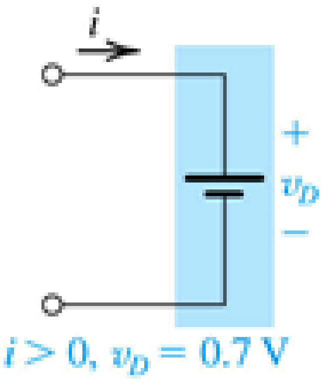
Diode Application → Rectifier Circuit



Problem Solving

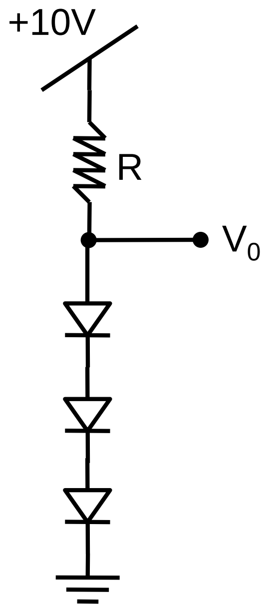
1) *verify appropriate current direction as a function of the time varying source*
2) *Assume status of diode according the current direction*

- **If diode is "on"**
  → $v_d = 0.7V$
  ∴ $I_d > 0$
- **If diode is "off"**
  → $I_d = 0V$
  ∴ $v_d < 0.7V$

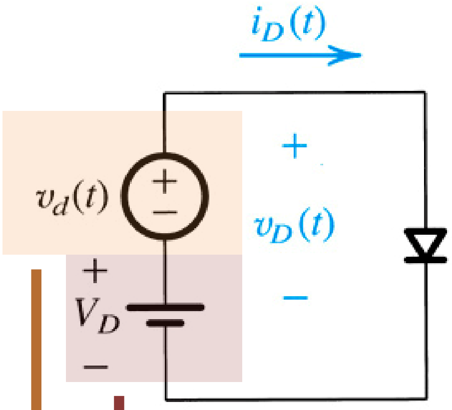


Problem D 4.11

Design the given circuit to provide an output voltage of 2.4V. Assume that the diodes available have 0.7V drop at 1mA.



Small-Signal Model



$$i_D = I_S e^{v_D/V_T}$$

$$i_D(t) = I_S e^{v_D(t)/V_T}$$
$$= I_S e^{(V_D + v_d(t))/V_T}$$
$$= I_{bias} e^{v_d(t)/V_T}$$

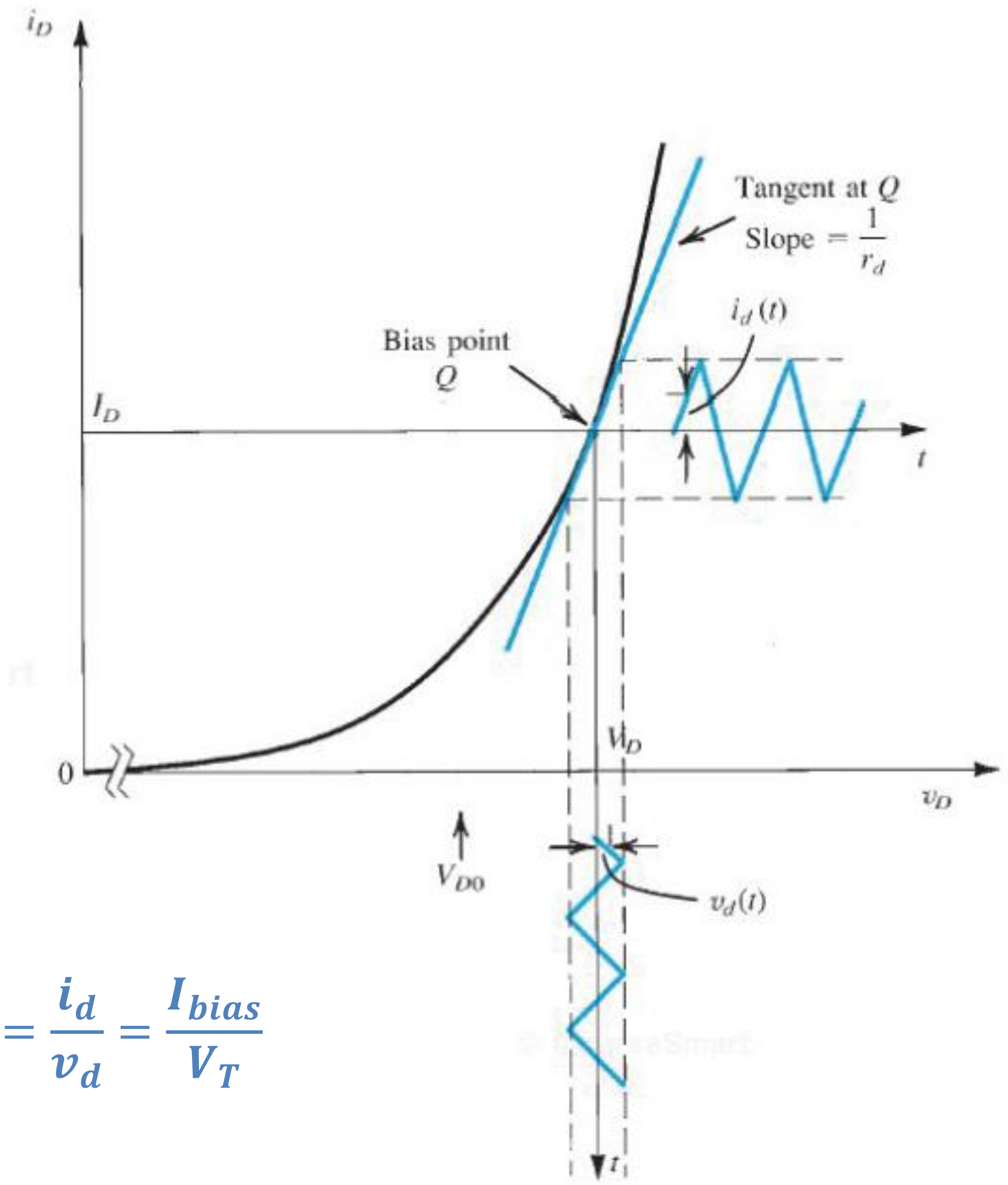
I_D $\quad \Delta I_D = i_d$

$$i_D(t) \approx I_{bias} + \frac{I_{bias}}{V_T} v_d(t)$$

$$\frac{1}{r_d} = \frac{\Delta i_D}{\Delta v_D} = \frac{i_d}{v_d} = \frac{I_{bias}}{V_T}$$

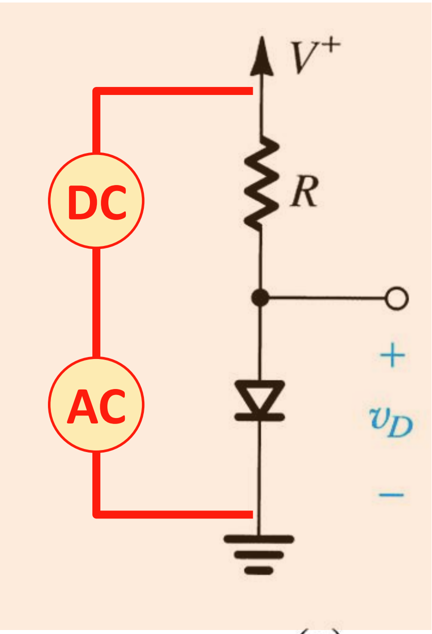
DC Signal
→ **stablishes the bias point**

AC Signal
→ **small changes at the bias point**

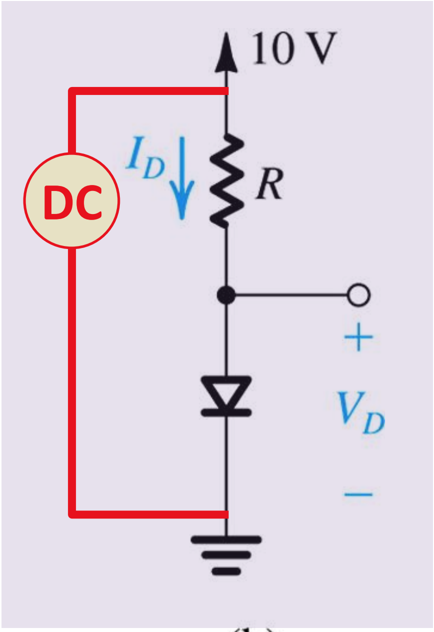


Small-Signal Model

- **Diode y modeled as a variable resistor**
- **Its value is defined via linearization of exponential model**
- **Around bias point defined by constant voltage drop model**



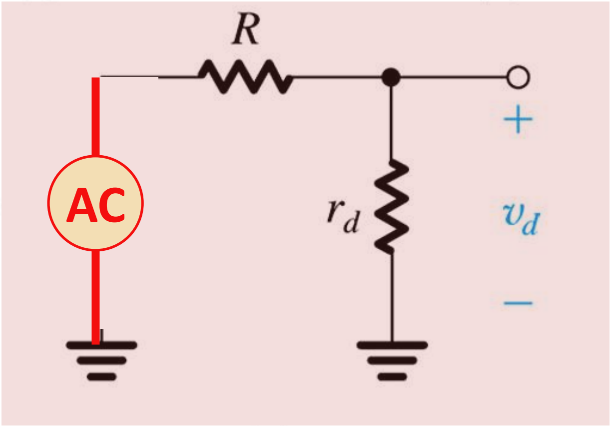
(a)



(b)

The total instantaneous circuit is divided into steady-state and time varying components, which may be analyzed separately and solved via algebra.

1) **In steady-state, diode represented as CVDM.**
2) **In time-varying, diode represented as resistor.**



(c)

Problem D 4.56

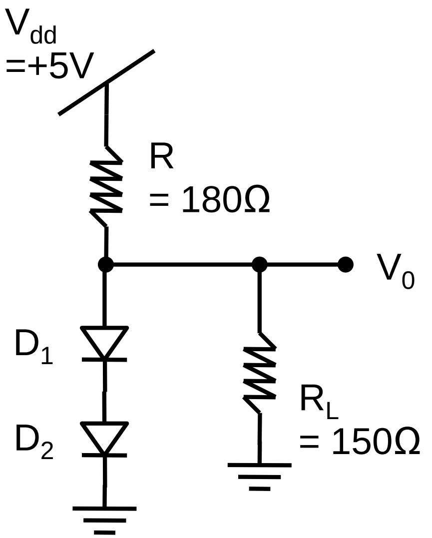
A particular design of a voltage regulator is shown below. Diodes D_1 and D_2 are 10-mA units; that is, each has a voltage drop of 0.7V at a current of 10mA. Use the diode exponential model and iterative analysis to answer the following questions:

a) What is the regulator output voltage V_0 with the 150Ω load connected?

b) With the load connected, to what value can the 5V supply be lowered while maintaining the loaded output voltage within 0.1V / 0.01V / 0.001V of its nominal value?

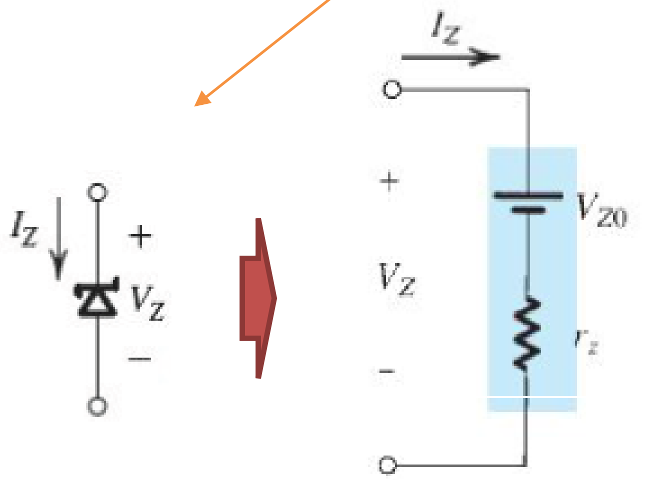
** for part b) use both the large signal model (exponential) and the small signal

ΔV_0	large signal model	small signal model
0.1V		
0.01V		
0.001V		



Zener Diodes → Chapter 4.4

- **Under certain circumstances, diodes may be intentionally used in the reverse breakdown region.**
- **These are referred to as Zener Diodes.**



Zener-Knee Voltage (V_{ZK})

$$V_z = V_z + r_z \cdot I_z$$

*** for $V_Z > V_{Z0}$

$I_Z > I_{ZK}$