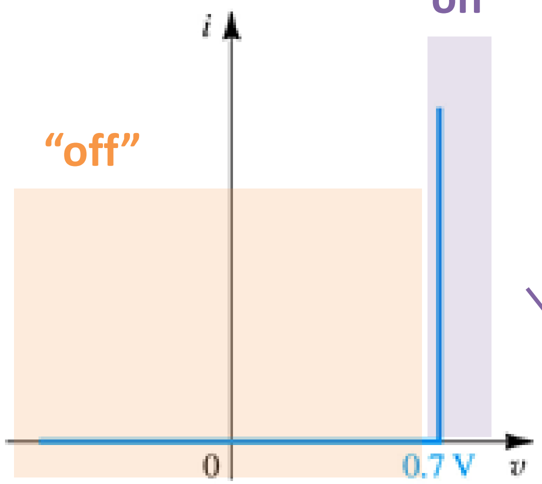
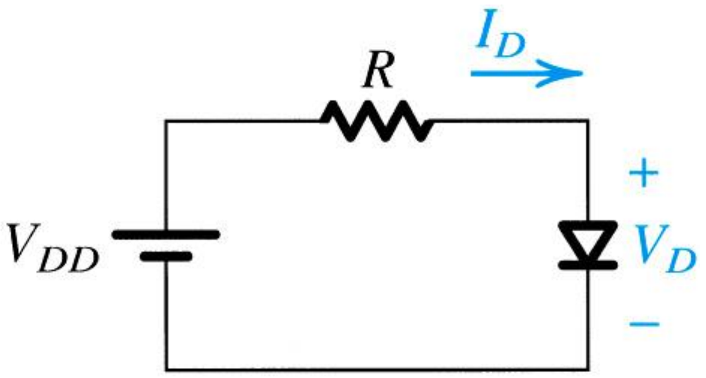
Last Lecture

DC Analysis

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

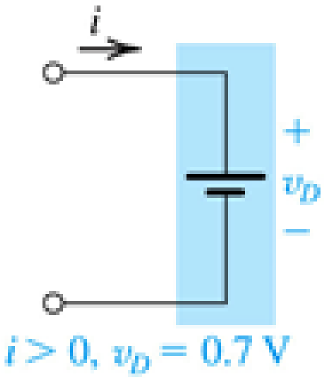




Constant-Voltage-Drop Model

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

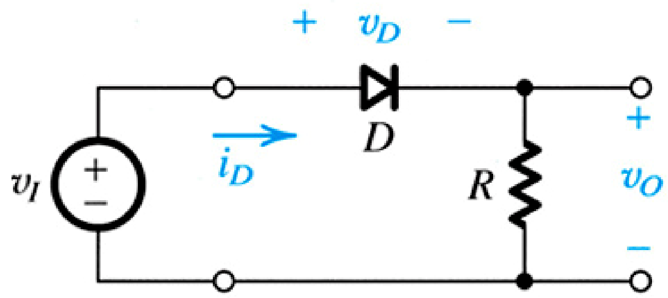
$$for\ I_D > 0 \rightarrow v = 0.7V$$

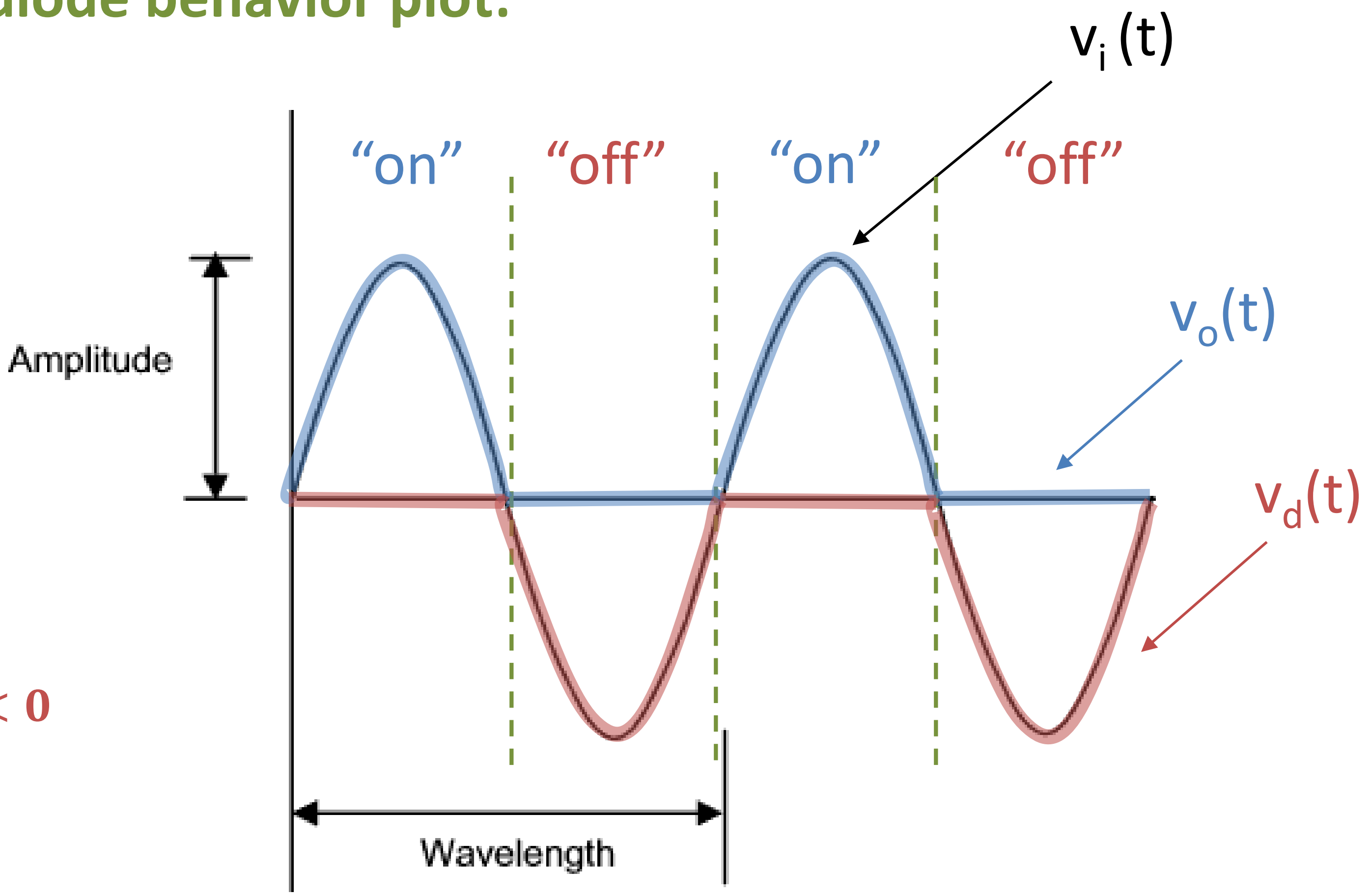


Diode Application → Rectifier

For the given circuit, assuming ideal diode behavior plot:

1) v_0 vs v_i
2) $v_0(t)$
3) $v_d(t)$





$D = \text{on} \rightarrow v_i > 0$

$v_0 = v_i$

$v_D = 0$

$I_D = \frac{v_i}{R}$

$D = \text{off} \rightarrow v_i < 0$

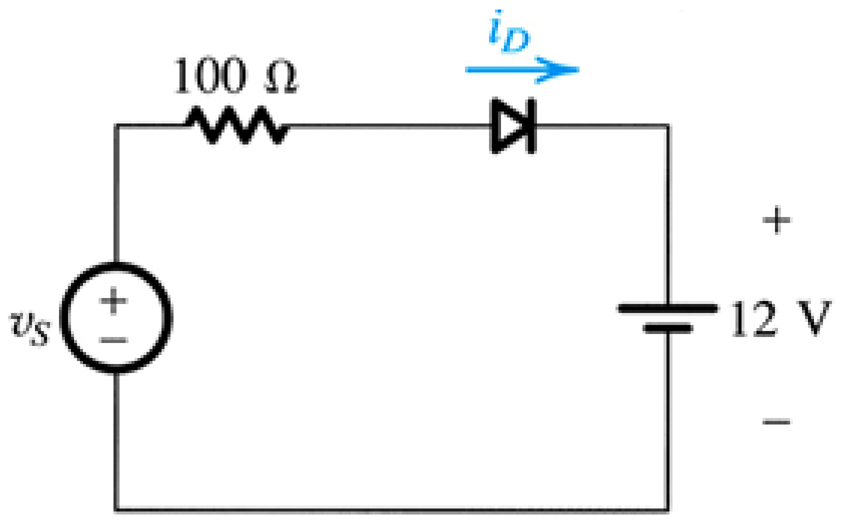
$v_0 = 0$

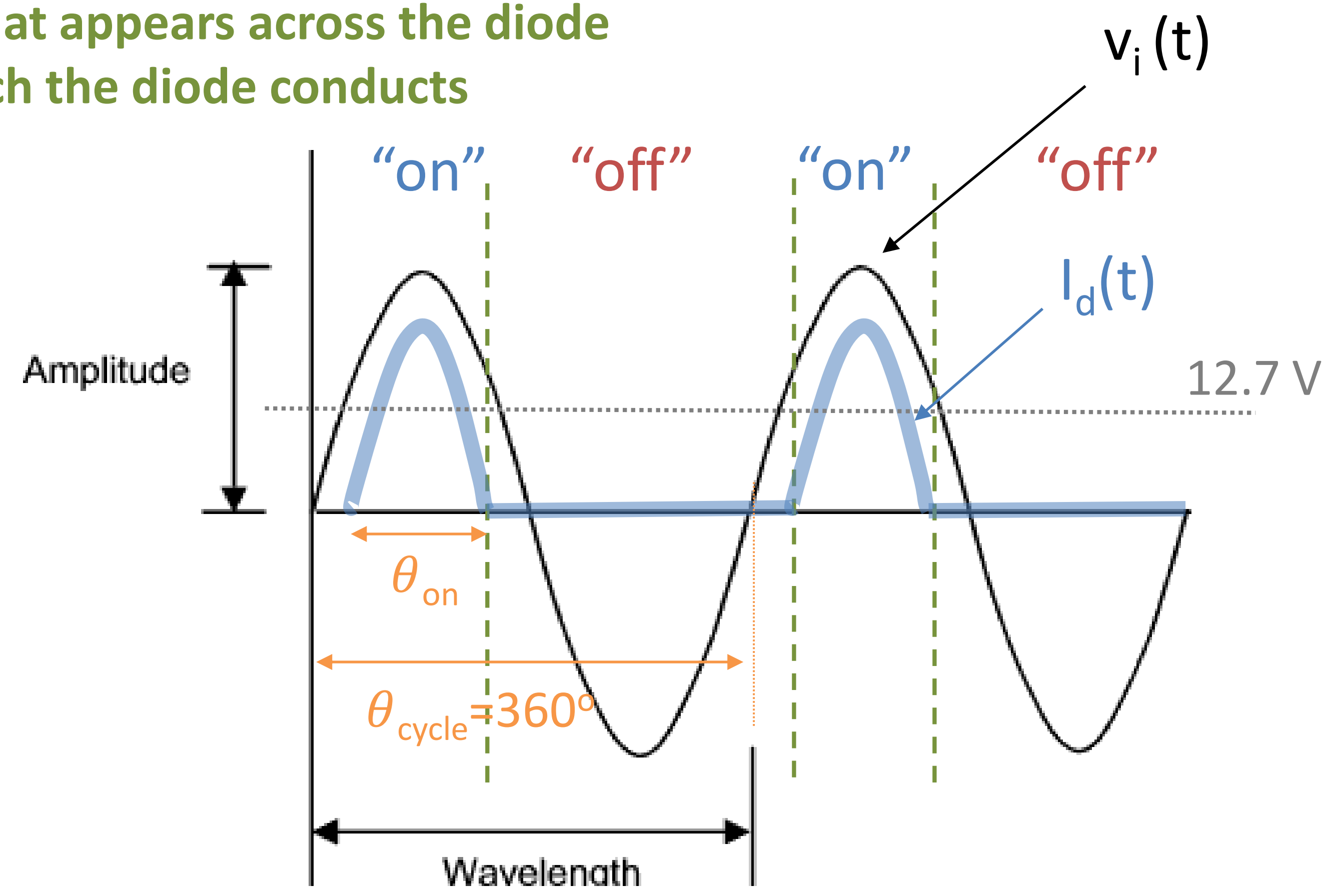
$v_D = v_i$

Example 4.1

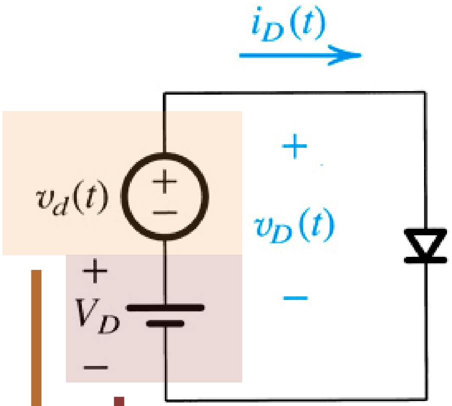
For the following circuit, assuming v_s is a sinusoid with 24-V peak amplitude and a CVD diode model find

a) the peak value of the diode current
b) the maximum reverse-bias voltage that appears across the diode
c) the fraction of each cycle during which the diode conducts





Small-Signal Model



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

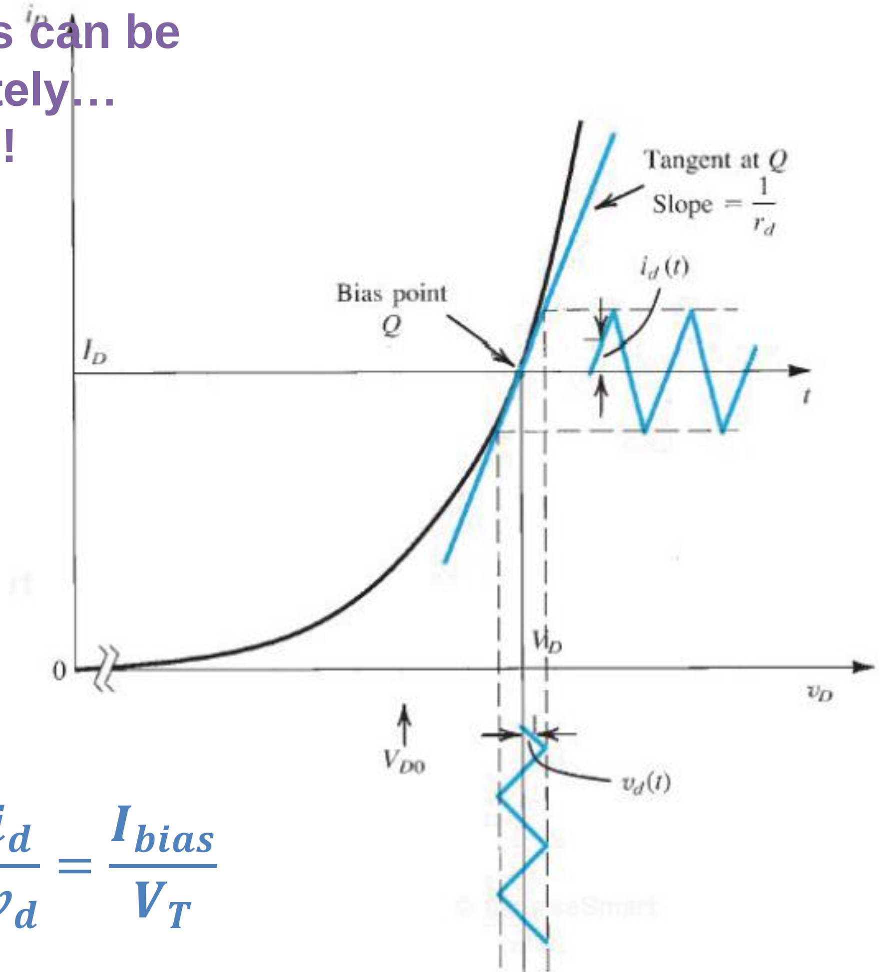
$$i_D(t) = I_S e^{v_D(t)/V_T}$$
$$= I_S e^{(V_D + v_d(t))/V_T}$$
$$= I_{bias} e^{v_d(t)/V_T}$$

DC AC

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

∴ DC and AC Analysis can be performed separately… superposition!

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



DC Signal

→ stablishes the bias point

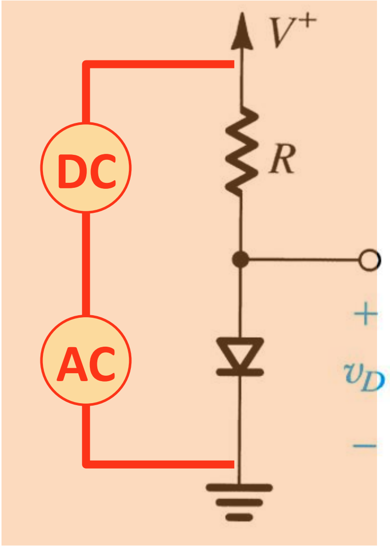
AC Signal

→ small changes at the bias point

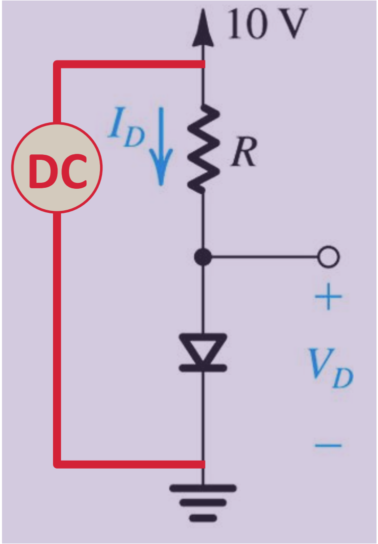
∴The AC behavior of the diode can be modeled as a resistor !

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



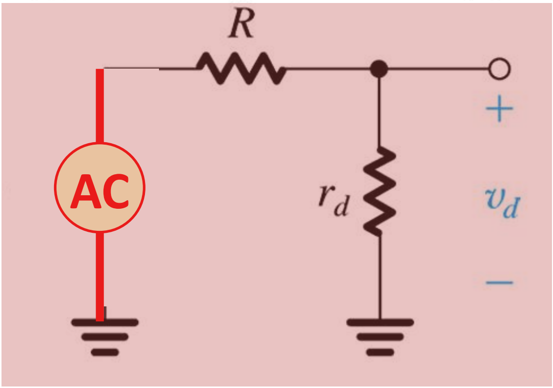
(a)



(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

$I_S = 69x10^{-16}$ A

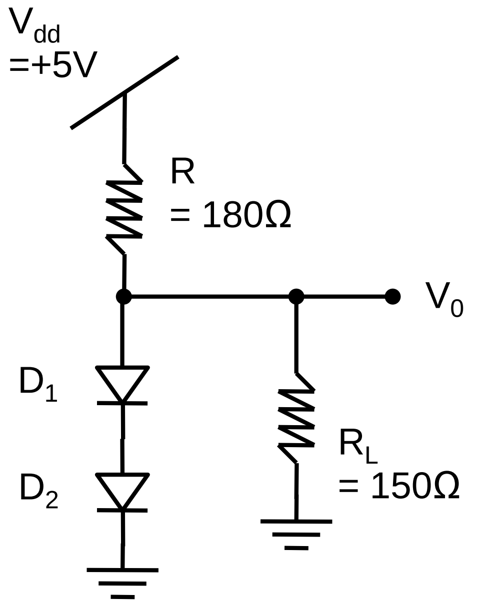
A particular design of a voltage regulator is shown below. Diodes D_1 and D_2 are 10-mA units; that is, each has a voltage drop of 0.7V at a current of 10mA. Use the diode exponential model and iterative analysis to answer the following questions:

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

b) With the load connected, calculate the output voltage change when the supply decreases 1V / 0.1V / 0.01V of its nominal value?

I_D = 10.63mA
V_0 = 1.403V

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



ΔV_{DD}	I_D large signal model	v_0 large signal model	Δv_0 large signal model	Δv_0 small signal model
1.0V				
0.1V				
0.01V				