## Lecture 16

Today we will

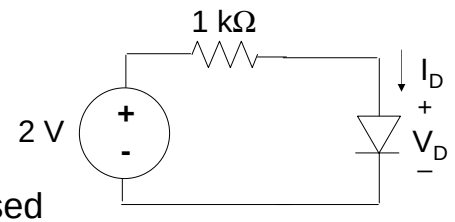
- Learn how to solve diode circuits
- Become proficient in the application of the different diode I-V models
- Gain experience “guessing” the correct diode mode for faster analysis

## Notes on Use of Models

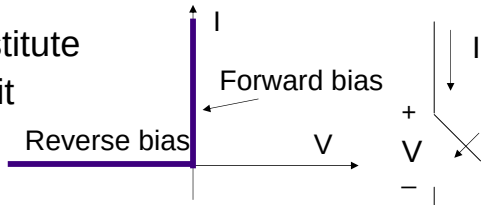
- Most of the diode models are piecewise defined:
  - One function for reverse bias
  - Another for forward bias
- You will need to:
  - “Guess” that diode is reverse (or forward) biased
  - Solve for V, I according to your guess
  - If this results in an impossibility, guess again
- Rarely, both guesses may lead to impossibility.
  - Use a more detailed model

## Example 1: Ideal Diode Model

Find $I_D$ and $V_D$ using the ideal diode model.




- Is the diode reverse biased or forward biased?
- Make a guess, substitute corresponding circuit for diode.
- "Reality check" answer to see if we need to re-guess.

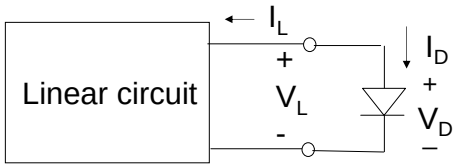






## Guessing the Diode Mode: Graphing

- Look at the diode circuit as a Thevenin equivalent linear circuit attached to a diode.

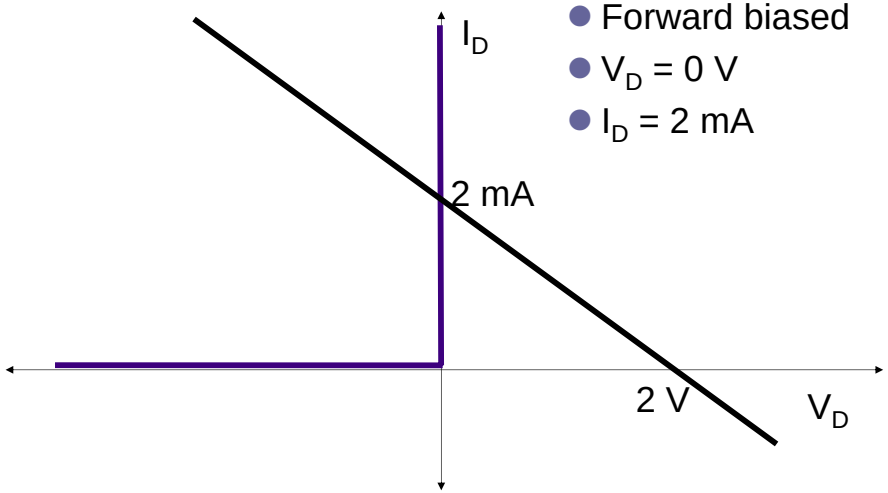



$V_L = V_D$

$I_L = -I_D$

- Graph the diode I-V curve and the linear circuit I-V curve on the same graph, both in terms of $I_D$ and $V_D$.
- This means draw the diode I-V curve normally, and draw the linear I-V curve flipped vertically ($I_L = -I_D$).
- See where the two intersect—this gives you $I_D$ and $V_D$.

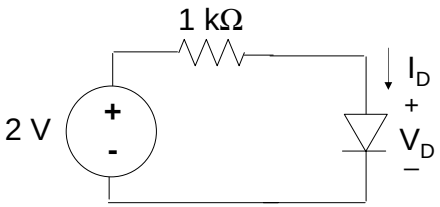
## Example 1: Ideal Diode Model




- Forward biased
- $V_D = 0$ V
- $I_D = 2$ mA

## Guessing the Diode Mode: "Common Sense"

We may notice:



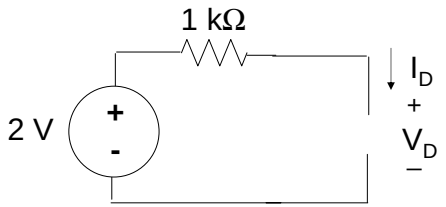

- Polarity of the 2 V falling over the resistor and diode
- The 2 V is in same direction as $V_D$
- Diode is probably forward biased

## Guessing the Diode Mode: When in Doubt…

- It's generally easier to guess **reverse bias** since it is easy to check.
- No matter what piecewise model we use, reverse bias is always open circuit.
- So when you don't know what to do, put in open circuit for the diode, and see if it violates reverse bias conditions (zero current, negative voltage).

## Example 1: Ideal Diode Model

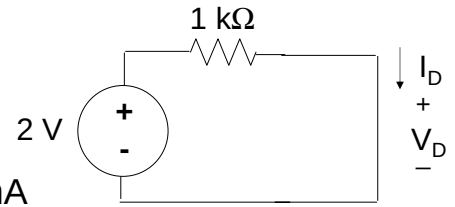
- Guess reverse bias:
- Since no current is flowing, $V_D = 2$ V (by KVL)




- This is impossible for reverse bias (must have negative $V_D$)
- So the diode must be forward biased

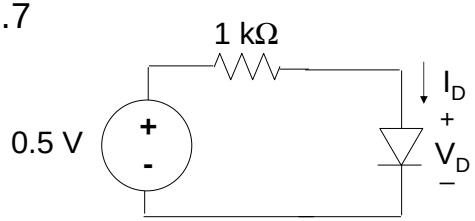
## Example 1: Ideal Diode Model

- We know diode is forward biased:
- $V_D = 0$ V
- $I_D = 2$ V / 1 kΩ = 2mA
- Same as what we got graphically.



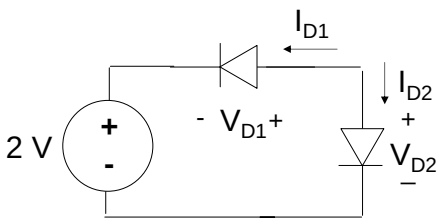

## Example 2: Large-Signal Diode Model

- Use the large-signal diode model with $V_F = 0.7$ to find $I_D$ and $V_D$.
- To be in forward bias mode, the diode needs 0.7 V.
- The source only provides 0.5 V.
- The resistor cannot add to the voltage since the diode could only allow current to flow clockwise.
- Reverse bias => open circuit => $I_D = 0$ A, $V_D = 0$ V



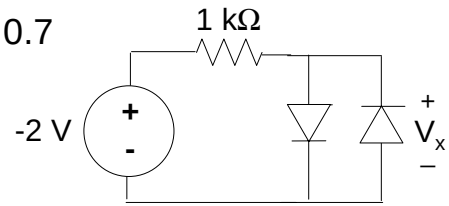
## Example 3: Large-Signal Diode Model

- Use the large-signal diode model with $V_F = 0.7$ to find $I_D$ and $V_D$.



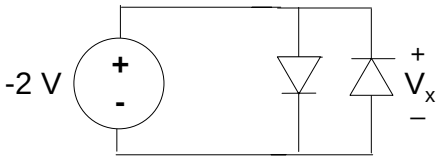

## Example 4: Large-Signal Diode Model

- Use the large-signal diode model with $V_F = 0.7$ to find $V_X$.



## Example 5: Ideal Diode Model

- Use the ideal diode model to find $V_X$.




## Example 6: Realistic Diode Model

- Using the realistic diode model with $I_0 = 10^{-6}$ A and $V_T = 0.026$ V, compute $I_D$ and $V_{OUT}$.