EE40
Lecture 26
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Reading: Chap. 10: Diodes
Load Line Analysis Method

1. Graph the $I-V$ relationships for the non-linear element and for the rest of the circuit.
2. The operating point of the circuit is found from the intersection of these two curves.

The $I-V$ characteristic of all of the circuit except the non-linear element is called the load line.
An ideal diode passes current only in one direction.

An *ideal diode* has the following properties:

- when $I_D > 0$, $V_D = 0$
- when $V_D < 0$, $I_D = 0$

Diode behaves like a switch:
- closed in forward bias mode
- open in reverse bias mode
Large-Signal Diode Model

Circuit symbol  \( I_D \)  \( V_D \)

I-V characteristic  \( I_D (A) \)  \( V_D (V) \)

Switch model  \( I_D \)  \( V_D \)

For a Si pn diode,  \( V_{Don} \cong 0.7 \text{ V} \)

RULE 1: When \( I_D > 0 \), \( V_D = V_{Don} \)

RULE 2: When \( V_D < V_{Don} \), \( I_D = 0 \)

\{ Diode behaves like a voltage source in series with a switch: 
- closed in forward bias mode 
- open in reverse bias mode \}
Diode: Large Signal Model

- Use piece-wise linear model
How to Analyze Circuits with Diodes

A diode has only two states:
- **forward biased:** $I_D > 0$, $V_D = 0$ V (or 0.7 V)
- **reverse biased:** $I_D = 0$, $V_D < 0$ V (or 0.7 V)

Procedure:
1. Guess the state(s) of the diode(s)
2. Check to see if KCL and KVL are obeyed.
3. If KCL and KVL are not obeyed, refine your guess
4. Repeat steps 1-3 until KCL and KVL are obeyed.

Example:

If $v_s(t) > 0$ V, diode is forward biased (else KVL is disobeyed – try it)

If $v_s(t) < 0$ V, diode is reverse biased (else KVL is disobeyed – try it)
Diode Logic: AND Gate

- Diodes can be used to perform logic functions:

  **AND gate**
  
  Output voltage is high only if both A and B are high

Inputs A and B vary between 0 Volts ("low") and $V_{cc}$ ("high")

Between what voltage levels does C vary when the diode requires a nonzero forward bias voltage to turn on?