Next week

- Review & Final

Lecture 11: Diodes

Administration: Schedule for last two weeks

- Monday: Finish Diodes
- Wednesday: Transistors
- Friday: Project
  1. Try & finish this week
  2. Next Thursday (11/8)
  3. Get signed off by a TA
  4. Requirement: NEXT THURSDAY (11/8)

Next week

- Homework #1: Due Friday

Hi! My class this week & next will be in 140 Cooper.

I will stay after class to help.

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Announcement! HW week 24 average is \( \approx 51/100 \).

1/3 of class still can't do proper nodal analysis.

Not good for finals!
Recall: Diodes

- Rectifier Diode
- Zener Diode

The breakdown of Zeners.

10.4 Ideal Diode Model

- Diode is modelled as a short-circuit for $V > 0$
- Diode is modelled as an open-circuit for $V < 0$
(2.) Find $V_x$.
[Assume diodes are ideal]

Steps: (1) Assume a state (on/off) for each diode in your circuit. If we have $n$ diodes, $2^n$ states!

[Word of advice: make an educated guess!]
(2) Solve circuit. =) find voltage across & current through each diode.
(3) Check assumptions for validity. See if a diode is off, \( i_{\text{diode}} = 0 \).
(4) If results are consistent, you are done. If not, go back to step 1 & try a different state!

\[ V_{\text{in}} = 10 \text{V} \]

\[ R_1 = 4 \text{k}\Omega \]

\[ R_2 = 6 \text{k}\Omega \]

\[ i = \frac{10 \text{V}}{4\text{k} + 6\text{k}} = \frac{1}{10}\text{mA} \]

\[ V_2 = 3 - V_x = -3 \text{V} \leq 0 \]
Hence, D1 is on and D2 is off.

Assuming D1 and D2 are ideal, sketch \( V_0(t) \).

Notice when \( V_{in} < 0 \), D1 and D2 are off.

\[ V_0 = 0 \text{ V} \]
When $V_{in} > 0$, we have to be careful about D1!

(Q1) What value of $V_x$ turns on D1?

A: $V_x = 4$ V

(Q2) For what $V_{in}$ does D1 turn on?

A: $V_{in}$ has to be at least 8 V! This is because D2 turns on before D1, i.e.

if $V_{in} > 0$, D2 is on. We can check this.
Guess: D2 is off, D1 is off.

V1 = V_x - V = 1 - 4 = -3

V2 = V_x = (V x \frac{1}{0}) = \text{turn D2 on, check D1 off}

Q: How do you know D2 turns on before D1?

A: Experience!
Therefore, D2 turns on before D1:

\[ V_x = \frac{1}{2} V_{in} \]

\[ V_{in} \text{ has to be at least 8V before D1 turns on!} \]
To sketch $V_0$: (1) $0 < V_{in} \leq 8 \ V \implies V_0 = V_\alpha = \frac{1}{2} V_{in}$

(2) $8 \leq V_{in} \leq 10 \ V \implies V_0 = 4 \ V$

More difficult diode problem: Fall 04, Hw 10 & 11. Solution should be in SP05 problem set (Hw 10 & 11). Ask us in OH for solutions.
Piecewise linear model(s):

\[ V - \frac{i}{R_{on}} \]

(1)

\[ V + \frac{i}{R_{on}} \]

(2)

maybe on HW, don't worry about piece-wise linear model for your final.
Diode applications

1. Rectification → converting AC to DC. You will build a half-wave rectifier in Lab tomorrow & Thursday.
(2) We put a big capacitor (22 μF) at \( V_R \).
This circuit is an example of using capacitors as filters.

Mathematically: \[ \mathcal{C} \rightarrow 2 \mathcal{C} = \frac{1}{j\omega \mathcal{C}} \]

1) Coupling capacitors is another example. You use these capacitors to eliminate DC.

\[ \mathcal{V}_{AC} \rightarrow \mathcal{C} \rightarrow 2 \mathcal{C} = \frac{1}{j\omega \mathcal{C}} \]

\[ L_{oc} = 2560 \]

\[ \omega_{oc} = 0 \text{ rad/sec} \]

\[ \omega_{oc} \rightarrow \infty \]
So, the cap gets charged to the DC value, but you want to let the AC signal through.

\[ |I_{dc}| \leq 0. \quad V_{c} = \frac{1}{j(2\pi f \cdot 2\pi f \cdot C_{ac})} \cdot \text{AC value.} \]

Finish diodes on Wednesday!