Announcements

• The midterm has been postponed until Wednesday, March 14th.
  - The midterm will cover everything up to and including chapter 11, and some of chapter 12 (Probably section 12.1).
• Problem Set #3 is posted, and is due this coming Friday, March 2nd, at roughly 11:59PM.
Electronics and power adapters
Observations about power adaptors
Observations about power adaptors

• AC power goes in and DC power goes out.
• Different adaptors have
  – different output voltages
  – different output currents
  – different input voltages
• Get warm when in use.
• While this is less obvious, different power adaptors supply different “qualities” of output voltage.
“Medium quality” power adaptor circuit
“Medium quality”
power adaptor circuit

- The circuit contains:
  - a transformer,
  - four diodes,
  - and a capacitor.
What do you get with nothing but a transformer?

* Induction Losses Generate Heat (not 100% efficient)
Diodes: one-way valves for electric current
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- Made from “doped” (impurities intentionally introduced) semiconductor materials.
- Pure semiconductors are normally insulators.
- Doped semiconductors are normally conductors.
  - **P-type**: Impurity ions make positive “holes”.
  - **N-type**: Impurity ions donate negative electrons.
- Diodes are made by forming a junction of P-type and N-type materials, called a P-N junction.
What can you do with one diode?

"Half-Wave" Voltage Rectifier ... AC to DC
Electrons in solids reside in what are called energy levels, which cluster into bands.
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- We can think of the energy levels as seats in a theater, which are there whether or not the electrons are present. Only one electron can fill each level, or ... one person to a seat!
- Halfway between the highest filled level and the lowest unfilled level is a point we refer to as the “Fermi level” which defines the top of the so-called Fermi-sea of electrons.
In a metal, the fermi surface fall right in the middle of a band.
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- Thus, there are plenty of unoccupied energy levels within the same band.
- We can think of this as the orchestra section being only part filled.
- If we want more people to come in from the right, the other people can accommodate by shifting one seat over toward the left.
- Thus, a partially filled orchestra section is a good people conductor.
In an insulator, the Fermi surface falls at a “band gap”, a region with no energy levels.
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- In this case, if we want people to come in from the right, the people already in the orchestra have no place to go.
- It is true that if you yelled really loudly to the person on the far left-hand side to get out of their seat, and they did, then everyone could move over one. But you can only yell so loudly!
In a photoconductor the band gap is small enough that a photon can knock an electron up to the conduction band.
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- Imagine that you have a gorilla roaming around the theater throwing people up into the balcony, thereby making more room in the orchestra section.
- This would cause our theater to be a kind of “gorilla conductor”. That is, in the presence of gorillas, it conducts people.
P-N junctions

(a) p-Type semiconductor
Conduction band
Band gap
Valence band

(b) n-Type semiconductor

(c) p-n junction
Conduction band
Band gap
Valence band

Depletion region

p-Type semiconductor

n-Type semiconductor

Power consumed = current · current · resistance
With doped semiconductors you have an excess of either holes (p-type) or electrons (n-type).

At a junction of p-type and n-type semiconductors, electrons drop down to fill the holes until Coulombic repulsion stops the process.

In the depletion region, the orchestra is once again filled, and no one can move.
Diodes

• If you add electrons from the right and pull them off from the left, (forward bias the diode), you replenish the electrons in the n-type semiconductor, replenish the holes in the p-type semi-conductor, and eliminate the depletion region. Now electrons can flow.

• If, on the other hand, you pull electrons from the right and push them in from the left, the depletion region grows and no current can flow.
capacitors
Capacitors

- Can be thought of as two parallel plates.
- When voltage is applied to them, charge flows onto the plates.
- When the voltage is disconnected, they store the charge.
- In some ways, they can almost act like a battery.
capacitors

Outside of capacitor

Inside of capacitor

Symbol for capacitor

Metal plates

Insulator layer
The diode bridge ensures that, regardless of whether the transformer is on a positive or negative cycle, positive charge is routed to the top wire.
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