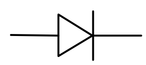
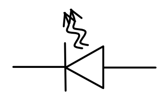
# OVERVIEW FOR AC POWER, SEMICONDUCTING DEVICES, AC CIRCUIT AND RADIOS

SEMICONDUCTORS

0.) What is a semiconductor? (insulating material that has been doped with an impurity giving it conductive properties)

1.) What is the difference between an n-type and p-type semiconductor? (n-type semiconductors have *electron conduction* while p-type semiconductors exhibit *hole conduction*)

2.) How is a diode made? (an n-type and p-type semiconductor are glued to one another) Also, how is a depletion zone generated. (depletion zones comes when the power supply's polarity forces holes and electrons to move away from one another, creating a conduction gap along the p-n junction—that gap, being depleted of free charge, is called the *depletion zone* and acts like a break in the circuit)

3.) What is the symbol for a diode?  and LED? 

4.) Be able to tell the direction of charge flow in an AC and DC circuit in which exists a diode. (direction of arrow in diode symbol—know how to tell this on a diagram)

5.) Be able to draw a circuit for a *half-wave rectifier*. (this is an AC power supply across a resistor and diode in series) Be able to reproduce its output across its load resistor (that is, what waveform will be generated by the device?) (it's lumpy and missing every other lump—look at supporting documentation in the Semiconductors pdf)

6.) Be able to draw a circuit for a full-wave rectifier. (this will be an AC power supply and a diode bridge) Be able to reproduce its output across its load resistor (that is, what waveform will be generated by the device?) (it's lumpy—look at supporting documents for this)

7.) What do *all* rectifiers do? That is, at their most basic, what is their purpose? (turn AC into DC)

8.) How do you get rid of the lumpiness in a full-wave rectifier? (with a capacitor across the load)

9.) What is ripple? (waviness in DC signals when the DC is generated from AC—it has to do with the fact that a capacitor has been used to keep the voltage across the load high when the waveform is trying to go to zero)

11.) What is the current characteristic (this is a graph—it's in the semiconductor pdf) for both *forward bias* and *reverse bias* of a diode? (see documentation in the Semiconductors pdf)

12.) When you put two diodes back-to-back, what do you get? What do you need to do to make a device like this useful? (it's a transistor—you need to make the base either positive or negative, depending upon the type of transistor)

13.) What are the two types of transistors (what are they called)? (n-p-n transistor and p-n-p transistor)

14.) For an npn transistor, what are the names of the terminals? (emitter, base, collector) How is this different for a pnp transistor? (same names but the current enters the emitter instead of the collector when turned on)

15.) Be able to reproduce the circuit symbol for a npn and a pnp transistor, and be able to tell the difference between a npn and a pnp transistor by looking at its circuit symbol. (to tell the difference, the arrow points away from the stop for an n-p-n . . . as far as reproducing the symbols, see documents)

16.) What three things does the arrow in a transistor symbol tell you? (direction of current flow when the transistor is turned on; the terminal that is the emitter; whether the transistor is a p-n-p or n-p-n)

17.) For what two things are transistors used? (they are used as amplifiers and switches)

AC CIRCUITS:

1.) An ammeter in an AC circuit reads 4 amps. The number tells you something. In short, what is it? (it tells you the RMS current for the circuit)

2.) Give a more complete answer to the question (that is, what *is* an RMS current?). (an RMS current is the size of the DC current required to provide the same amount of power to the circuit as does the AC current)

3.) You see a circuit has a power supply whose voltage is $169 \sin 377t$. What do you know about the circuit? (the power is coming from a wall socket)

4.) What does an RMS voltage tell you? (similarly to the answer in #2, it gives you the size of the DC voltage required to provide the same amount of power to the circuit as does the associated AC voltage)

5.) An AC power supply characterized as $V(t) = 16 \sin 80t$ is put into an RLC circuit in which the inductance is 3 mH, the capacitance is $7\ \mu F$ and the resistance is $180\ \Omega$.

a.) draw the circuit (complete with symbol for the AC power supply); (all the elements are in series—see "AC Circuits" document for an example of this)

b.) Determine the RMS value of power supply's voltage; ($V_{RMS} = .707V_o$, where the amplitude of the voltage function $V_o = 16$ . . . see V(t) function above)

c.) Determine the frequency of the power supply. (the frequency is buried in the time coefficient—"80" in this case; the relationship is $V(t) = V_o \sin(2\pi\nu t)$, so $2\pi\nu = 80$ in this case and $\nu = \frac{80}{2\pi}$)

d.) If an ammeter were put in this circuit, what, *in general*, would its reading give you? (the RMS value of the circuit's current)

5.) The power supply from the previous problem stays the same, but the frequency is changed to 3600 Hz. All the circuit's parameters stay the same. That is, the inductance is still 3 mH, the capacitance is $7\ \mu F$ and the resistance is $180\ \Omega$.

a.) What, in general, does the circuit's *capacitive reactive* tell you? (the frequency-dependent resistive nature of the capacitor—its units are actually OHMS, just like resistor-like resistance)

b.) In AC circuits, capacitors act like what kind of filter? (high pass filter) What does this mean? (they allow high frequency signals to exist in a circuit while wiping out low frequency signals)

c.) What is the circuit's *capacitive reactance* $X_C$?

( $X_C = \frac{1}{(2\pi\nu C)} = \frac{1}{\left[\left(2\pi(3600)(7\text{x}10^{-6})\right)\right]} = 6.3\ \Omega$ )

d.) What, in general, does the circuit's *inductive reactive* tell you? (the frequency-dependent resistive nature of the inductor—its units are OHMS)

e.) In AC circuits, inductors act like what kind of filter? (low pass filter) What does this mean? (they allow low frequency signals to exist in a circuit while wiping out high frequency signals)

f.) What is the circuit's *inductive reactance* $X_L$? ( $X_L = 2\pi\nu L = 2\pi(3600)(3\text{x}10^{-3}) = 67.9\ \Omega$ )

g.) What, in general, does the circuit's impedance Z tell you? (the net resistive nature of the circuit, in OHMS)

h.) What, in general, does the phase shift tell you? (by how much the voltage leads or lags the current in the circuit)

i.) What is the circuit's net *impedance* Z?

$$Z = \left(R_{net}{}^2 + (X_L - X_C)^2\right)^{1/2} = \left[(180)^2 + \left(2\pi(3600)(3\text{x}10^{-3}) - \frac{1}{\left[\left(2\pi(3600)(7\text{x}10^{-6})\right)\right]}\right)^2\right]^{1/2} = 190\ \Omega$$

j.) What is the circuit's *resonance frequency*?

$$\nu_{res} = \frac{1}{2\pi}\left(\frac{1}{LC}\right)^{1/2} = \frac{1}{2\pi}\left(\frac{1}{(3\text{x}10^{-3})(7\text{x}10^{-6})}\right)^{1/2} = 1098\text{ Hz}$$

k.) What is the current in the circuit? ( $i_{RMS} = \frac{V_{RMS}}{Z} = \frac{.707(16\text{ V})}{190\ \Omega} = .06\text{ amps}\ \ (60\text{ milliamps})$ )

8.) Let's assume the RMS voltage of the power supply is 15 volts. Let's assume that the impedance of the circuit at a given frequency is 8 Ω. What is the RMS current in the circuit?

$$i_{RMS} = \frac{V_{RMS}}{Z} = \frac{15\text{ V}}{8\ \Omega} = 1.875\text{ amps}$$

RADIOS:

1.) What is the mechanism that transfers information from a radio station to a radio receiver? (electromagnetic wave)

2.) Be able to draw a simple *radio station circuit*. (look at sketch in the Radio pdf)

3.) Why are there no radio waves below 500,000 Hz? (below 500,000 Hz, the EM disturbance generated around the sending antenna has enough time to collapse back down onto the antenna before the next disturbance is set up; above 500,000 Hz, it doesn't have time to do the collapse so it instead flips off leaving as an EM wave)

4.) What does the number associated with a radio station mean. That is, KFWB's station number is "98." What does that number tell you? (multiply it by 10xkHz and it gives you 980,000 Hz—that is the frequency the FCC gave the station to send out its signal—that's the frequency of its information wave)

5.) What happens when an electromagnetic wave passes by a piece of metal like an antenna? (if it's a straight metal antenna, the *alternative electric field* part of the EM wave will motivate charge to flow as AC in the metal; if it's a circular antenna, the *changing magnetic field* part of the EM wave will motivate charge to flow as AC in the coil —in both cases, you get AC charge flow)

6.) How does an AM radio select out the station you've decided you want to listen to? (the radio has an RLC tuning circuit whose capacitor or inductor is variable and that has a characteristic resonant frequency $\nu_{res}$, depending upon the size of the cap or inductor; when all the signals from all the radio stations superimpose their signals on the antenna, the antenna transfers all that into the tuning circuit via a transformer and the only signal that proliferates is the signal that matches that resonant frequency)

7.) What does AM stand for? FM? (AM stands for *amplitude modulation* and FM stands for *frequency modulation*)

8.) Let's say an AM radio station is given one million hertz to work with. How does it put information on that wave? Draw a sketch of the process. (the station *modulates the amplitude* of the carrier wave the FCC licensed to them so that its envelope (its outline) matches the outline of the information wave (what you are trying to send)—an example of this is found in the Radios pdf)

9.) Why do you need a diode in the speaker circuit? (what comes into the speaker circuit via a transformer from the tuning circuit is a high frequency, amplitude modulated wave—a speaker can't respond to that as AC, but it can as DC—in other words, the speaker needs the modulated wave to be in the form of DC so the speaker can "decode" the information off the wave)

10.) How does an AM radio decode the information riding on the carrier wave? (in simple circuits, a speaker can't respond to a million cycles per second but it can respond to the trend of current changes; as the current changes mimic the information wave, the speaker acts as a decoder)

11.) Be able to draw an AM receiver circuit (the entire radio circuit) with AND without amplification (that is, with a transistor to amplify the signal). (look at the documentation in the Radios pdf)