Midterm Review

Physics 181, F09

The midterm will be **Wed Oct 21 2:30-4:30**. You may use a 3"x5" card of notes (both sides). No phones, no calculators.

Present *clear* and *complete* answers. Unjustified answers will earn no points. Well-reasoned answers can receive partial credit. Answers may require explicit calculation, written explanation, and/or diagrams to be complete.

DC circuits

1. Analyze a circuit consisting of resistors and batteries. Be able to calculate the
   (a) current in any branch
   (b) voltage at any point, relative to ground
   (c) voltage difference between any two points in the circuit
   (d) power provided or used by the components

   by using either the equivalent resistance method or Kirchoff current and voltage laws.
2. Determine the Thevenin equivalent circuit for a given resistor-battery configuration.
3. Given a Thevenin equivalent circuit, show that the circuit will provide a maximum
   (a) voltage to the load when $R_L \gg R_{Th}$.
   (b) power to the load when $R_L = R_{Th}$.
4. Given an input voltage V_{in} and load resistance R_L, design a voltage divider to output a desired voltage V_{out}.

   Include a circuit diagram, resistor values and labeled input/output terminals.
5. Draw the circuit for measuring the IV curve of (a) a passive element and (b) an active element.

   A complete answer will include terminals for the ammeter and voltmeter.

AC circuits

1. Calculate V_{rms} for a given periodic $V(t)$.
2. On an oscilloscope, what is
   (a) the "trigger" for and how do you set it? Include channel, level and slope in your answer.
   (b) the difference between AC and DC coupling?
   (c) the probe setting and what should you set it to?
3. How are frequency and angular frequency related? Which one do most sources and meters display?
4. Given an oscilloscope trace, write the expression for an oscillating voltage in the form of $V(t) = V_0 \cos(\omega t + \phi)$.

   And the reverse.
5. Consider a circuit consisting of a sinusoidal input voltage $V_0 \cos(\omega t)$ and a capacitor C. Use Kirchoff's laws and the definition of capacitance ($C \equiv Q/V$) to show that
   (a) the current in the circuit is also sinusoidal with the same frequency, but lags the voltage by $\pi/2$.
   (b) the current has an amplitude of $V_0/\omega C$.
6. How is capacitive reactance (or impedance) the same as resistance? How are they different? Your explanation must include their relationships to currents and voltages in an ac circuit.

   And the same for inductive reactance.
7. Analyze an ac circuit consisting of a sinusoidal input voltage, resistors, capacitors and inductors. In particular, determine the
   (a) voltages associated with the components
   (b) current in any branch
   (c) relative phases of the voltages and currents
   (d) power provided or used by the components

   by using impedances and complex-voltage diagrams.
8. (a) Derive the gain and phase shift for a given ac circuit. (b) Analyze the gain and phase shift in certain limits or values of frequency ($\omega \to 0, \omega \to \infty, etc.$).
9. Identify any characteristic frequencies for a given ac circuit and describe what occurs at (or below or above) these frequencies.

Diodes

1. What is the main difference between an n-type and a p-type semiconductor?
2. Describe the motion of the charges in an unbiased pn junction. Focus on the regions both within and far from the interface. Include a sketch, indicating any regions with net charge and any electric fields present.
3. Draw a reverse biased pn juntion. Describe the motion of the charges.
4. Draw a forward biased pn junction. Describe the motion of the charges.
5. What is a diode's "turn-on voltage" and how can it be determined for a given diode? In your answer, refer to and make a sketch of a diode's IV characteristic.
6. Given a diode-resistor circuit and an input voltage V_{in}, determine the output voltage V_{out}.
7. Identify, design, or explain the behavior of the following diode circuits:
   (a) a half-wave rectifer
   (b) ... with a smoothing capacitor
   (c) a full-wave rectifier
   (d) a clipping circuit