Topics for Midterm 2:

1. Everything from Midterm 1 (but I wouldn't bother going back and studying earlier stuff, because you've been constantly using all the most important stuff)
2. Basic properties of capacitors and inductors [everything on the cap/inductor cheat sheet]
3. Solving 1st order RL and RC circuits
    a. Writing out and solving 1st order ODEs [by whichever method you want, e.g. separation of variables, method of particular and homogeneous equations, intuitive method for DC sources]
        i. Note the mistake I made on the board in class the first time we discussed RL circuits. $\tau = L/R$ for the intuitive method, not $-R/L$ (which is the root of the characteristic polynomial [the equation you get when you replace i' by s])
    b. But aren't these all the same? Can't you just combine all the resistors together and just have a simple RC or RL circuit?
        i. No, you can have dependent sources!
        ii. No you can have op-amps (HW5 problem 3)
        iii. Source may be some kind of strange thing like $v(t) = 5t$ Volts
    c. Understanding how to calculate when the source has reached 63.2% of its final value (or some other amount). So if you have $v(t) = 2e^{-\frac{t}{4}}$, you should know how to find how long it takes to decay to 63.2% (same as $(1 - \frac{1}{e})$) of 2 (it's easy, just some algebra)
4. Terminology: Particular solution a.k.a. forced response a.k.a. steady state response. Homogeneous solution a.k.a. natural response a.k.a. transient response.
5. Finding initial and final conditions in arbitrary RLC circuits (like problem 14 on HW4 or the question on the pop quiz I handed out), this basically comes down to using:
    a. The fact that for DC sources, capacitors eventually act as open circuits (because eventually voltages will settle down and if dvC/dt=0, then no current in capacitor)
    b. The fact that for DC sources, inductors eventually act as closed circuits (similar reason)
    c. That when a switch is flipped somewhere in a circuit at time $t = \tau$
        i. $v_C(\tau) =$whatever it was right before switch flipped for each capacitor
        ii. Note: $v_C'(\tau)$ can be ANYTHING (because current is allowed to instantly change!)
    d. That when a switch is flipped somewhere in a circuit at time $t = \tau$
        i. $i_L(\tau) =$whatever it was right before switch flipped for each inductors
        ii. Note: $i_L'(\tau)$ can be ANYTHING (because voltage is allowed to instantly change!)
    e. KVL and KCL
6. Setting up arbitrarily large ordinary differential equations for any number of Rs, Ls, Cs
    a. No need to solve these!
7. Understanding of how to solve 2nd order LC circuits (see handwritten notes for lecture 10 (http://inst.eecs.berkeley.edu/~ee40/su10/lectures/lec10/) or if you did it the long way on problem 2 of HW 5)
8. Qualitative understanding of RLC circuits:
    a. If you have an RLC circuit with some non zero initial condition, what can it do?

    b. I'd put the formula for a series RLC and a parallel RLC circuit on your cheat sheet. I won't give you a problem which will just be an application of this formula, but it might help with some intuition on a problem yet to be written maybe]
9. Phasors – what they are. Just a complex number which represents a sinusoid
10. Using impedances to solve for the PARTICULAR solution a.k.a. forced response a.k.a steady state of arbitrary RLC networks
    a. You don't HAVE to use phasors. I know that at least one of you guys prefers the method in the book where you replace sources by complex sources, and then do impedances, then find the real part. I think this is more work, but you're free to do this
11. Understanding of what happens when two impedances sum to zero
    a. If $v_1^{ss}(t)$ and $v_2^{ss}(t)$ denote the steady state solutions (a.k.a. particular solutions a.k.a. forced responses) of the two node voltages connected by the impedances in question , then $v_1^{ss}(t) = v_2^{ss}(t)$
12. Understanding of what happens when two impedances sum to infinity (for example $-10j$ and $10j$ in parallel)
    a. Steady state current flowing in to the box containing those impedances (like if you draw a circle around them) is zero
    b. Current may still flow within the box (see HW6, problem 1)
13. Deriving Transfer functions
14. Conceptual understanding of what a transfer function is
    a. Using transfer functions to calculate magnitude and phase response for a given input
15. Understanding of how transfer functions are sensitive to loads (just like the $v_O = v_{in}/1000$ voltage divider from homework 1 was sensitive to the load resistor). Also how op-amps help avoid this problem (just like they did when we talked heavily about op-amps)
16. Making Bode Plots on a loglog scale for magnitude and a semilogx scale for phase
    a. Sorry that these weren't taught well. I assumed more knowledge of loglog plots, so I started a little too far into the process during lecture and moved a little too quickly. This probably made HW6 really frustrating in parts.
    b. If you're uncomfortable with these, see my long filter case study (http://inst.eecs.berkeley.edu/~ee40/su10/notes/filter_case_study.pdf)
    c. If you want, remember you can always just plug in points into your equation directly instead of thinking of asymptotes
    d. If you can do HW6 problem 6 and the case study example, you will be more than fine
    e. Understanding of the terminology "low frequency asymptote" and "high frequency asymptote"
        i. Low frequency asymptote is basically just the behavior of a function as ω gets very small. So for a lowpass filter, the low frequency asymptote is a constant plateau where ω doesn't really do anything when it gets small enough.
        ii. High frequency asymptote is basically just the behavior of a function as ω gets very large. So for a 1st order highpass filter, the high frequency asymptote is that the system is inversely proportional to ω, which on a loglog plot will be a

downward sloping line. However, just understanding that it's inversely proportional to ω is the key concept

1. [note the order of a filter isn't required terminology, but basically for a 2nd order high pass, it's inversely proportional to ω^2 and so on]

17. Definition of a low pass, high pass, band pass, and band stop (a.k.a. notch) filter. Conceptual understanding of when these might be useful
18. Key concepts in lab that GSIs have noticed you guys not really getting, for example:
    a. Schmitt Triggers – conceptual understanding of how they work and the fact that they have hysteresis
    b. Use of op-amps with no feedback (e.g. lab 4)
    c. Using potentiometers for voltage division. Using potentiometers as a variable resistor.

Specifically don't need to know:

1. How to solve RLC circuits from scratch
2. How to use phasors to calculate power
3. Details of Thevenin and Norton equivalents for Impedance circuits (though the concept might maybe make some problem easier, but it's a low priority item)
4. How to show summing point constraint works in RLC circuits (though it is cool)
5. How to pick an R so that a 3rd converges most quickly (HW5 problem b, which incidentally will be not for a grade. It's doable without ODEs but hard)
6. Quality factors of filters (Q)