Review for Final Exam

Final Exam guidelines

The final will be Monday March 18th at 8:00 AM. You may bring one single-sided sheet of notes on US Letter paper. You may also bring a calculator, but please no complicated devices with stored equations. There will be four to six questions taken from any of the topics we have covered in this course. Emphasis will be on analyzing or designing circuit elements, although many of the concepts we covered earlier in the course may be necessary, for example complex impedance in analyzing filters. The first and second midterm reviews are also posted on the website, and should be consulted as well.

DC Circuits

The fundamental rules of Ohm’s Law and Kirchoff’s current and voltage laws are needed in analyzing almost any circuit. Be careful with your definition of the current direction in each segment, as this also defines the direction of the voltage drop as related by Ohm’s law. Don’t forget the simple rules for resistance in parallel and series. Also, you should be comfortable (or at least functionally proficient) with the idea of Thevenin equivalent voltages and resistances, particularly as we used them in the labs to consider input and output impedances. Make sure you can analyze the input or output impedance of simple circuit elements like a voltage divider.

Don’t forget the relationships for power in DC circuits and the various ways this can be expressed using Ohm’s law.

Also, don’t forget how to handle diodes in DC (or AC) circuits. Remember how to apply the two possible hypotheses about forward or reversed biased diodes to test whether the diode is conducting, then apply the proper condition depending upon which hypothesis is true.

AC Circuits

We developed a useful framework for analyzing AC circuits in terms of complex voltages and impedances. This should be your main tool for analyzing AC circuits, particularly filter circuits (either active or passive). Understand that the complex transfer function \( \tilde{T}(\omega) \) describes both the voltage gain and phase shift of a circuit, and be able to find these from the magnitude and phase of \( \tilde{T}(\omega) \) respectively, particularly in the high and low frequency limits. Also, you should be able to quickly identify critical frequencies from the complex transfer function without having to explicitly solve for the magnitude. Be able to sketch the voltage response of a circuit on a Bode plot, and know what to expect for lo-pass, hi-pass, band-pass, and notch filters. Also remember that LC combinations usually lead to resonance behavior, that will be apparent in the transfer function as a real pole in the denominator (frequency where the denominator goes to zero) implying an infinite gain.
Transistor circuits

We looked at transistors both for DC behavior and AC behavior. Know how to analyze and set up DC characteristics using our simple transistor model, and understand which voltage differences are fixed (from base to emitter) and which can vary (from collector to emitter). Understand how transistors can be used to switch loads, and the impact of saturating a transistor (usually a good thing for switching) on the power dissipation in the transistor.

Understand the main AC transistor circuits we studied, including the emitter follower, current source, common-emitter amplifier, and differential amplifier. Know how to either analyze a circuit given to you or to design one of these circuits given a set of design parameters. Often the design process involves making reasonable assumptions. Understand what those are. Also remember the main equations governing the $I_D-V_{GS}$ behavior of FET devices, particularly JFETs. You should be able to compare a circuit like an emitter follower between a BJT and JFET implementation.

Be ready to include the intrinsic emitter resistance (transconductance) in problems where an emitter resistor is small or dropped. Understand how this primarily will impact the gain of a circuit, and how for a JFET this is often not negligible (even if there is an emitter resistor).

Operational Amplifiers

Be able to apply the golden rules to analyze or design OpAmp circuits. This could include amplifiers, followers, active filters, arithmetic voltage operations (voltage/current adders, multipliers, etc), rectifiers, and so on. Be able to quickly analyze simple inverting and non-inverting amplifiers with linear (RLC) components using the complex impedance formalism. Understand, at least qualitatively, the limitations of OpAmps and the conditions where they start to deviate from ideal opamp behavior. This includes solving simple problems using realistic gain equations, and also understanding (or at least estimating) input and output impedance in standard op-amp circuit configurations for non-infinite open-loop gain.

Comparators and Oscillators

Understand how a Schmitt Trigger works, and be able to analyze any positive feedback circuit by considering the two possible output states of the device ($\pm V_0$). Understand how to find the trigger points for the transition from $+V_0$ output to $-V_0$ output, and realize that once flipped, the trigger points will likely change.

Understand the reason why a relaxation oscillator works, and be able to apply similar logic to other RC circuits charging or discharging from a constant voltage.