Review for First Midterm

Midterm guidelines

The midterm will be Thursday January 30th during our normal class time. You may bring one single-sided sheet of hand-written notes on US Letter paper. You may also bring a calculator, but please no complicated devices with stored equations. There will be around four questions taken from the topics we have discussed in class up through week 3 (HW 1-3) including diodes and the simple model for BJT transistor behavior with DC voltages. All homework solutions are posted on Canvas. You will have the entire class period Thursday to complete your exam.

DC Linear Circuits

Understand Ohm’s Law, \( IR = V \), and how to apply it to DC circuits. Understand Kirchoff’s current and voltage laws and know how to use these to find \( V \) or \( I \) at places in circuits. Understand how to simplify resistor networks using the parallel and series resistor rules. Be able to analyze voltage divider problems and simple networks with voltage or current sources. Also remember that power is given as \( P = IV \) and be able to calculate the power dissipated in resistive components.

Know what is meant by the Thévenin voltage and resistance, and be able to apply this concept, particularly in the context of the loading which results from chaining together two parts of a circuit. One specific case we considered was adding a load to a voltage divider. Remember that \( R_{Th} \) is a derived quantity which comes from \( V_{Th}/I_{short} \). Understand that finding the open-circuit voltage and short-circuit current from the output of a circuit can always be used to find \( R_{Th} \). Finally, realize that only linear components (RLC, plus voltage or current sources) can be replaced by a Thévenin equivalent. In particular, a circuit involving a diode can not be simplified in this way, although the part of a diode circuit not involving the diode certainly can be.

AC Linear Circuits

Be able to analyze simple RC circuits in the time domain in terms of capacitor charge-discharge cycles. Know what the equation for exponential discharge looks like, and be able to calculate the voltage change after a given time knowing \( RC \). In the frequency domain, know which configurations give rise to a lo-pass or hi-pass filter, and understand why these can also be thought of as integrators or differentiators.

Understand the meaning of the “decibel” unit and be able to quote AC amplitude ratios in terms of decibels. Remember that attenuation gives -dB.

Remember that for AC signals, \( P_{avg} = I_{RMS}V_{RMS} \) where the RMS values are \( \sqrt{2} \) smaller than the peak amplitudes.

Complex Analysis
Be familiar with the notation of complex voltages and currents. Understand the generalization of Ohm’s law to complex impedances: \( I \tilde{Z} = \tilde{V} \). Be able to convert the complex representation back into a real AC voltage or current by taking the real part, i.e.: \( V(t) = \Re[\tilde{V}(t)] \). Remember the formulae for the impedance of resistors, capacitors, and inductors, and be able to use these impedance values to calculate the complex transfer function \( \tilde{T}(\omega) \) or the real amplitude transfer function \( T(\omega) = |\tilde{T}(\omega)| \) for simple voltage-divider circuits using any combination of L, R, or C. Be able to find \( T(\omega) \) from \( Z_2/(Z_1 + Z_2) \) as well as the phase as \( \tan \phi = \Im[\tilde{T}]/\Re[\tilde{T}] \). Understand how KCL, KVL, series and parallel impedance rules, and Thévenin equivalents all generalize to the complex case. Be able to calculate the input and output impedance for a simple voltage-divider combination of L, R, or C components, and how you might use that to avoid loading (such as in our pass-band filter problem on HW2).

Know what a Bode plot is and how to sketch the response function in proper units on a Bode plot. Know what the “-3 dB point” means and be able to calculate it from the transfer function.

Diodes

Know what the I-V curve of a diode looks like, and be able to apply the simple diode model (+0.6 V forward voltage drop) to analyze simple diode circuits like voltage clamps, rectifiers, and resistor + diode circuits (like HW3).

Be able to properly use a current limiting resistor to keep the current in an LED within a reasonable range.

DC Transistor Circuits

Understand how to check the simple transistor design rules \( V_{BE} = 0.6 \text{ V}, V_{CE} \geq 0.2 \text{ V} \) and use the current amplification \( I_C = \beta I_B \) to analyze simple transistor circuits involving DC voltages. Understand what saturation means, and how to check for a saturated transistor. Realize what you need to modify \( (V_{CE} = 0.2 \text{ V} \) and \( I_C = \leq I_B \)) when a transistor is saturated. I will not ask you anything about AC signals through transistors or the input/output impedance of a circuit involving a transistor on the first midterm.