1. Prelab for Lab 3.

2. Schottky diode thermal runaway. Use the data sheet for the MBR10100 for the following calculations.
   (a) At 125°C, what would power dissipation in the diode be if it were subjected to a continuous reverse bias of 100 V?
   (b) If the diode is used with no external heat sink, the steady state temperature of the junction in degrees C is the ambient temperature, plus 60 times the dissipation in the junction in watts. (The thermal resistance from junction to ambient is 60°C/W.) What would happen if the junction were heated to 125°C, and then 100 volts applied, with no heat sink in a 90°C ambient? (Tell the story of what happens, being quantitative where possible. Note that the scale on the plot you will use is a bit funny—each decade in the log scale has lines for 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, whereas typical ones omit the 1.5. You can tell this because the second two lines are closer together than the first two, and because of the number of lines per decade.)
   (c) What is the maximum safe voltage that could be applied to the device with the junction starting at 150°C, with no heat sink, in a 20°C ambient?

3. (a) You are designing a circuit with a MOSFET conducting a continuous 10 A rms current. The MOSFET’s on-resistance at 25°C is 40 mΩ, and you have it water cooled, so the junction is in fact operating near 25°C. You replace it with a MOSFET with twice the die size which has a 20 mΩ on-resistance at 25°C. If you use the same water cooling, by what factor does the power dissipation decrease?
   (b) Same question, with the same FET, but with only a small heat sink, such that the original FET operates with a junction temperature of 150°C (in a 25°C ambient). Again you replace it with a FET with twice the die area, with a 20 mΩ on-resistance at 25°C, but you continue to use the same small heat sink. How much does the dissipation decrease? The new FET is in the same package and uses the same heat sink. Assume that temperature rise (above ambient) is proportional to dissipation. The new FET does not operate at the same junction temperature. You will need to iterate to find the actual junction temperature. Use Figure 4 of the IRF540 data sheet.

4. Switching losses with stray capacitance. A capacitor is connected to a voltage source by a switch in series with a resistor. The capacitor is initially discharged, and the switch is open. The switch in turned on at t = 0. In class we found that the total charge supplied by the source was CV, and thus the energy supplied was CV². But the capacitor only gains energy of 1/2CV², so another 1/2CV² is lost. Check where this energy goes by calculating the energy dissipated in the resistor. Start by finding the current as a function of time; then integrate Rit²(t)dt to find energy lost. Is this consistent with what we said in class? Can you reduce the loss by adjusting the resistor value?