EE394V Homework Assignment #4, parts I and II

Due date: 1/12/2009

For all questions elaborate some few conclusions or comments about the results. For all questions with simulations include a graph with the used model. State all the assumptions considered in the simulations. Part I and Part II will be graded separately, each with a maximum possible score of 100. Only one of the grades for the two parts may be discarded when calculating the home works final grade.

Part I

1) Consider an IRFPS3810 MOSFET with an unclamped load of R = 10 Ω and L = 500 μH. Simulate the turn-on and turn-off transients for V_{DD} = 50 V. Sketch the turn-on and turn-off trajectories on the safe operating area (SOA) graph and determine whether or not it is acceptable to operate the MOSFET in these conditions. You may use the previous model for the MOSFET and even simplify it by leaving only the capacitances that provide the predominant behavior, but, please, explain your choices. Fir example, for the MOSFET model you may neglect C_{gd}, consider all other capacitances constant, and also neglect the effect of the temperature in the parameter values.

2) Repeat problem #1 when a turn-off snubber is added to the MOSFET. You may select for the snubber component values that you consider to be appropriate.

3) Find a paper that proposes or discusses at least one lossless snubber circuit. In a short paragraph explain how the proposed snubber works and what are its advantages and disadvantages.

Part II

4) Consider an IRFPS3810 MOSFET operating with a turn-off snubber and an unclamped load of R = 1.25 Ω and L = 100 μH. The switching frequency is 50 kHz, V_{DD} = 50 V, and the duty cycle is 0.5. Also, assume that T_J should stay below 100 C. What is the minimum length of the heatsink if it is used a model 63730 from Aavid Thermalloy (http://www.aavidthermalloy.com)? You may approximate the switching losses by considering a factor a = 3.5 and a total switching time calculated from the times given in the MOSFET datasheet (although these times may not lead to an exact calculation because the load is different).

5) Consider a single phase H-bridge inverter with a modulation signal given by $m(t) = 0.85\cos(2\pi 60t)$. Plot on the same figure one cycle of the output fundamental signal, and the output voltage if NSPWM is used. Repeat the plot with UPWM. Compare the results. Plot the spectrum for both cases and compare the results. Plot also the state sequence. Consider that the switching frequency is

21 times the fundamental frequency and the input voltage is 100 Vdc. NOTE: The switching frequency allows for a clear representation of the signals and the effect under analysis, but it also has a practical implication: 1.2 kHz is a typical switching frequency that can be found in high-voltage applications.

6) For this problem consider a three-phase inverter with a modulation signal on phase *a* equals $m_a(t) = m(\cos(2\pi 50t) - (1/6)\cos(6\pi 50t))$, and a switching signal 21 times the fundamental. Plot the spectrum up to 50 times the fundamental for v_a and v_{ab} for m = 1, 1.1, and 1.2.