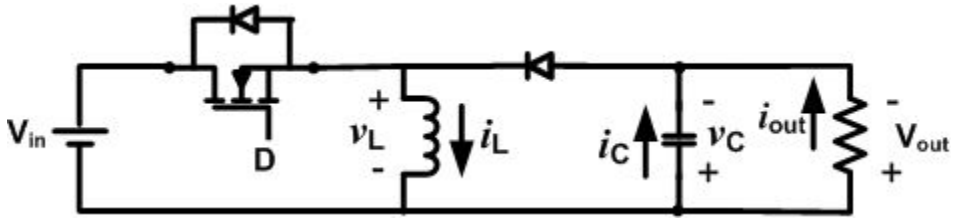
EE362L – Spring 2009, Test 2

Please, show all your work on the test sheets. A correct answer without supporting work gets no credit. One sheet of notes is permitted. Write your name in all pages. Do not un-staple. You have 50 minutes to complete the test. Hint for most of the problems: KVL and KCL apply in the average sense. Also always consider that you are operating in steady-state with ideal components.

Problem 1 (25 points)

Use KVL and KCL in their average sense and indicate the relationship between V_{out} and V_{in} for the buck-boost converter in the circuit below. Please, also indicate I_{out}/I_{in} and the output voltage ripple $\Delta V_{out,\ p\text{-}p}$. Assume that you are operating this dc-dc converter in continuous conduction mode.



$$0 = V_{in}D - (1-D)V_{out} \rightarrow \frac{V_{out}}{V_{in}} = \frac{D}{1-D}$$

$$P_{in} = P_{out} \rightarrow V_{in}I_{in} = V_{out}I_{out}$$

$$\frac{I_{out}}{I_{in}} = \frac{1-D}{D}$$

When $Q = on \rightarrow$

$$I_{out} = C\frac{\Delta V_{out}}{\Delta t} = C\frac{\Delta V_{out}}{DT}$$

$$\Delta V_{out} = \frac{I_{out}DT}{C} = \frac{I_{out}D}{Cf_{sw}}$$

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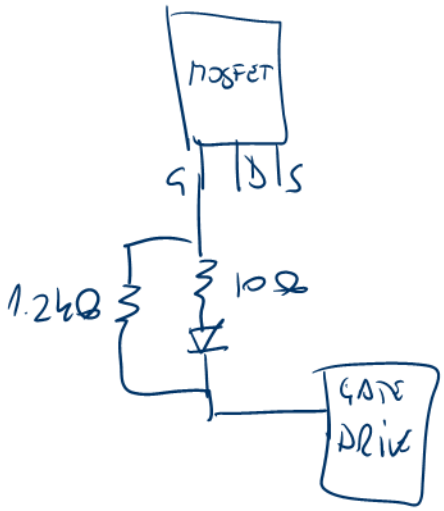
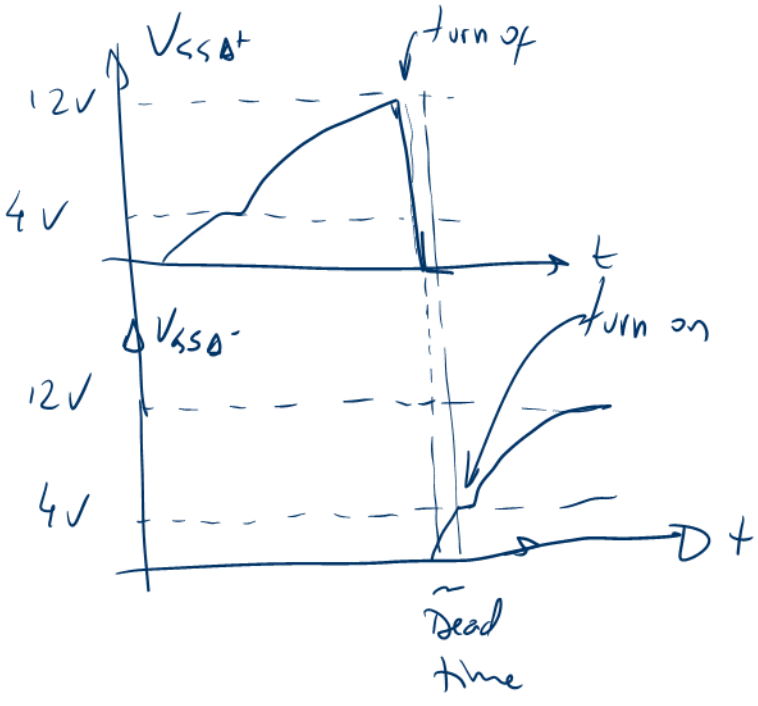
Problem 2 (25 points)

Draw a schematic for a blanking time circuit in an H-bridge inverter (just the blanking time portion of the firing circuit) and explain how it works. In the circuit indicate some approximate values for your circuit components. Also, carefully sketch the gate-source voltage for both switches in the same inverter leg and provide an explanation for the waveforms shape (you may assume that the switches turn on at 4 V and that the firing circuit power supply voltage is 12 V). Why do you need to have a blanking time in an H-bridge inverter?





We want to have a dead time to avoid shoot-through conditions

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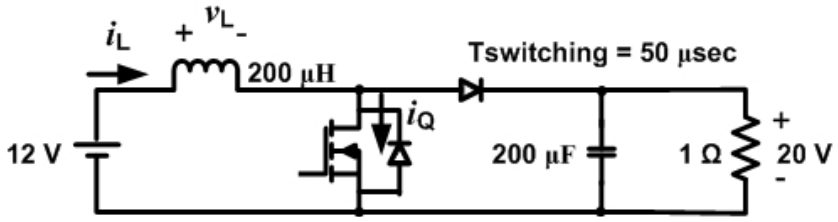
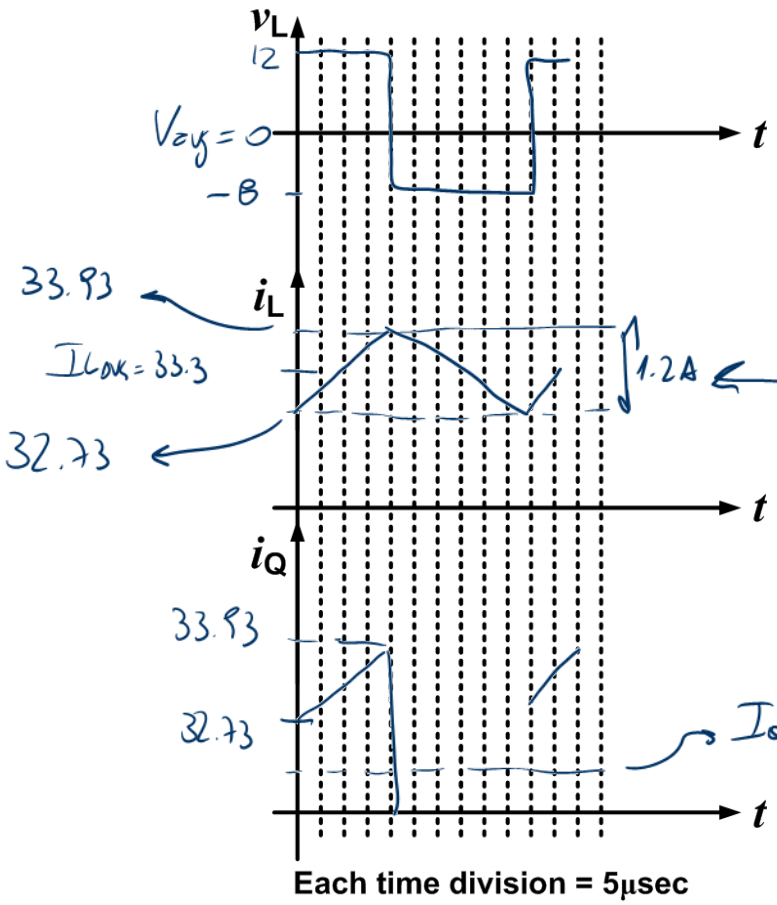
Problem 3 (30 points)

Consider the boost converter in the figure. On the graph below, carefully and neatly draw the following variables: $i_L(t)$, $v_L(t)$, and current in the main switch ($i_Q(t)$). Also specify the most significant values (peaks and average value). Consider that you are operating in continuous conduction.





$1-D = \frac{V_{in}}{V_{out}} = 0.6$

$D = 0.4$

$I_{OUT} = 20A$

$I_{in} = \frac{P_{out}}{V_{in}} = \frac{400W}{12V} = 33.3A$

$\Delta I_{in} = \frac{V_L}{L}\Delta t = \frac{12}{200 \cdot 10^{-6}} 0.4 \cdot 50 \cdot 10^{-6}$

$\Delta I_{in} = 1.2A$

$I_{Q\,AVG} = I_{LOAD} D = 33.3 \cdot 0.4 = 13.32A$

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Problem 4 (5 points each)

Please, select the correct answer for the following questions. Provide a brief justification for your answer.

4.1) Consider a buck converter. What is the effect on the inductor current if I_{out} is lowered and V_{in}, D, L, and $f_{switching}$ remain unchanged.

a) Δi_L and I_L decrease
b) Δi_L and I_L remain unchanged
c) Δi_L remains unchanged and I_L decreases
d) Δi_L increases and I_L decreases
e) Δi_L remains unchanged and I_L increases
f) None of the above

See slide 16 buck converter ppt

4.2) Consider a buck converter. What is the effect on the inductor current if $f_{switching}$ is increased and V_{in}, D, L, and I_{out} remain unchanged.

a) Δi_L and I_L decrease
b) Δi_L and I_L remain unchanged
c) Δi_L decreases and I_L remains unchanged
d) Δi_L decreases and I_L increases
e) Δi_L increases and I_L decreases
f) None of the above

see slide 17 buck converter ppt

4.3) Consider a buck converter. What is the effect on the inductor current if L is lowered and V_{in}, D, $f_{switching}$, and I_{out} remain unchanged.

a) Δi_L and I_L decrease
b) Δi_L and I_L remain unchanged
c) Δi_L decreases and I_L remains unchanged
d) Δi_L decreases and I_L increases
e) Δi_L increases and I_L remains unchanged
f) None of the above

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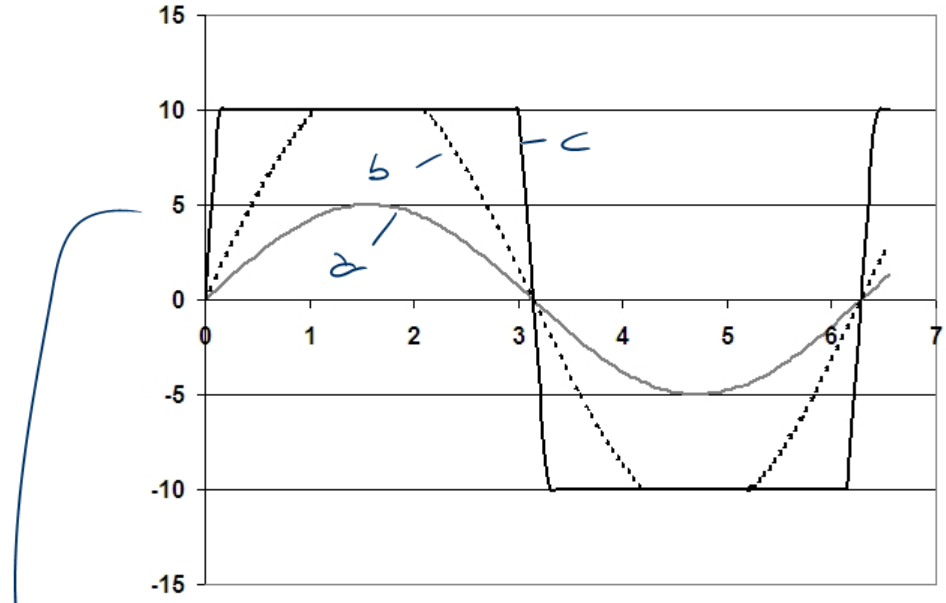
4.4) Please, indicate which of the three curves in the plot below corresponds to an H-bridge inverter operating in

a) linear regime
b) overmodulation regime
c) Saturation regime

Indicate the modulation index for a).



$$m_{linear} = \frac{5}{10} = 0.5$$