Full-bridge converter exercise sheet

1) Draw the following waveforms over two switching cycles: $v_{oi}, v_L, i_L, i_{D1}, v_o$ and v_1 (the voltage on the primary winding of the transformer). Assume $r_L = 0$ and C very large and the inductance of the transformer is negligible (compared to L).
2) What will happen to the waveforms of $r_L \neq 0$? Does it matter on which side of the inductor we connect this resistance?
3) Write the state space representation of the two forms of the circuit (one when either pair of switches "on", the other when all switches are "off").
4) Write the state space matrices of the average system (using the results from 3). We define $D = \frac{t_{on}}{T_s/2}$. Assume V_{in} is constant.
5) Write a transfer function from D to v_o. What will be the small signal transfer function if we linearize the system as was taught in the lecture? Is the transfer function proper? Is it stable? What kind of generic DC/DC converter does it resemble?
6) Write the expression for the output impedance.
7) Assume a switching frequency of 10kHz, $V_{in} = 200\text{V}$, $v_o = 20\text{V}$. Choose the values of C and L such that (a) the voltage ripple at the output would be at most 1V (peak-to-peak), when the converter delivers 100W and (b) there is no resonance between the output current (in the band up to 100Hz) and the LC filter.
8) Calculate the output impedance of the circuit from question 7.
9) How can we achieve an output impedance 10 times smaller? Think of feedback!