ANALOG SYSTEMS : PROBLEM SET 6

Problem 1

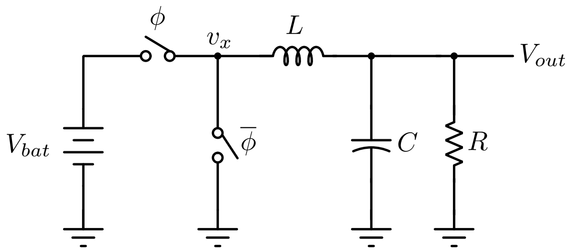

Figure 1: Circuit for Problem 1.

Fig. 1 shows a buck converter. The battery voltage V_{bat} is 5 V. ϕ and $\overline{\phi}$ are complementary switch drive signals. The duty cycle of ϕ is denoted by D. The switching frequency is 1.5 MHz. $L = 2.2\,\mu$H and $C = 22\,\mu$F. The load resistor $R = 10\Omega$.

- Determine D needed to achieve $\overline{V_{out}} = 3.3$ V.
- Determine the transfer function from v_x to V_{out}.
- Using the observation that the pole frequency of the LC filter is much lower than the switching frequency, determine the ripple in the inductor current and output voltage.
- Sketch the current waveforms in the inductor and capacitor in steady state.
- Sketch the voltage waveform V_{out} in steady state.

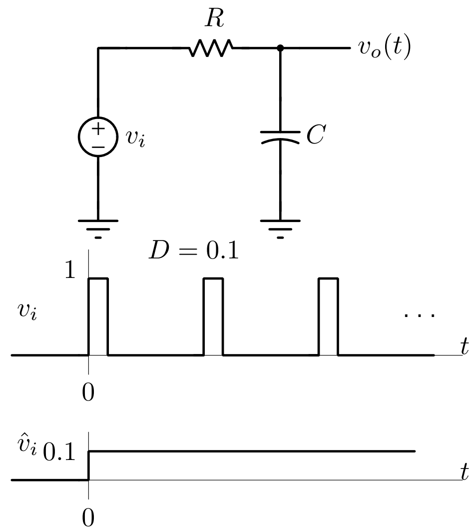

Figure 2: Circuit for Problem 2.

Problem 2

In class, we saw that the response of a "slow" linear time-invariant system to a rapidly varying input like v_i in Fig. 2 is approximately the same as that due to $\hat{v}_i$. In this problem, we will convince ourselves of this by working a specific example.

Assume that v_i has a frequency of 1 MHz, and a duty cycle of 10%. $RC = 1$ mS. On the same graph, plot $v_o(t)$ when the input is $v_i(t)$, and when it is $\hat{v}_i(t)$.

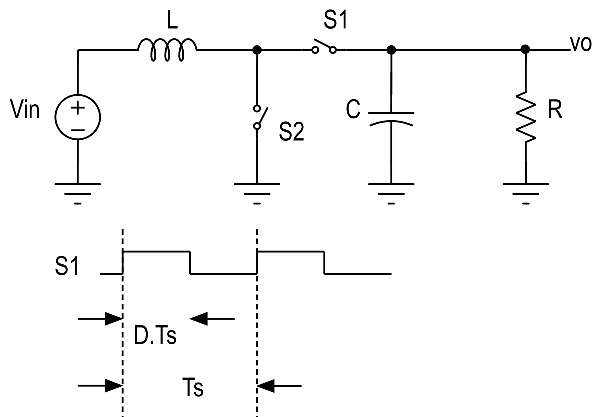

Figure 3: Circuit for Problem 3.

Problem 3

As usual, the switching period Ts is much smaller than the time-constant of the LC network. S1 and S2 are controlled by complementary waveforms, and the waveform controlling S1 is shown in the figure. Determine the average output voltage vo, and the average current drawn from the source. Draw the steady state current and voltage waveforms through/across the inductor and capacitor.