Exercise 1

Calculate the Fourier series of the unfiltered output,u_{oi}, of the buck converter. What are the highest Fourier components in the input and output of the filter. How the variation in the load influences the functioning of the circuit? In the calculation, you may use the function $h(x)$ (figure 1) which corresponds to the switching with D, the switch duty ration. $U_d = 40\text{V}$, $U_o = 5\text{V}$, $P_o \geq 5\text{W}$, $L = 43,75\mu\text{H}$, $C = 470\mu\text{F}$ and $f_s = 50\text{kHz}$

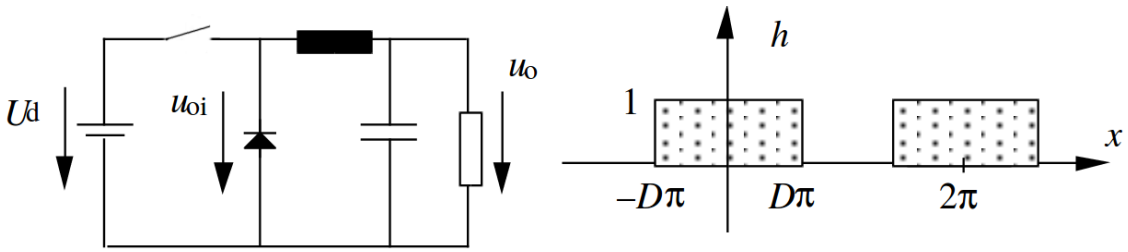

Figure 1: Buck converter and the switching function h.

Exercise 2

a) Using figure 2 (first without taking in account L_1 and C_1), draw the current i_d, when $P_o = 5\text{W}$, $U_d = 40\text{V}$, $U_o = 5\text{V}$, $L = 43,75\mu\text{H}$ and $f_s = 50\text{kHz}$. The output voltage is considered to be constant.
b)Using the complete figure 2, let's consider that the inductance L is large enough that the current i_L is constant. Calculate the spectrum of the current i_d. You can use the same switching function h (figure 1) of the previous exercise. The peak value of the harmonic current $\hat{i}_{d1}$ must be limited to $0,2\text{mA}$. What is the maximum authorized resonance frequency ω_o.

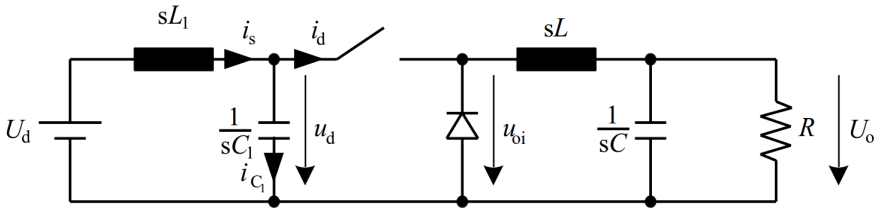

Figure 2: Buck converter.

Exercise 3

A boost converter is represented in the figure 3, plot the current i_L, i_k, i_D, i_C and i_o and the voltages U_o, U_D and U_L.

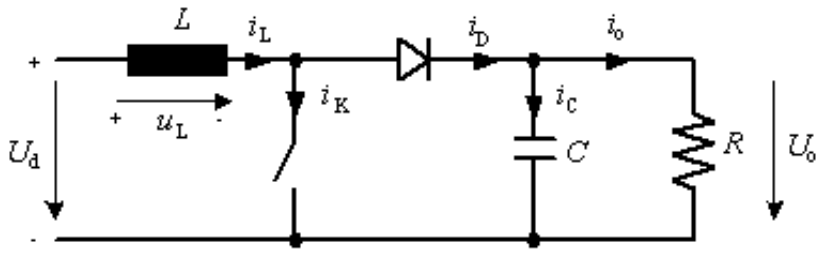

Figure 3: Boost converter.

What is the relation between average output current i_{oB} and the average input current i_{LB}? The output voltage of the boost converter $U_o = 24\text{V}$ is set to be constant with a duty ratio D. The input voltage is limited with $8\text{V} \leq U_d \leq 16\text{V}$. The output power is $P_o \geq 5\text{W}$, the switching frequency is $f_s = 20\text{kHz}$, $C = 470\mu\text{F}$. Calculate the value of the choke L that keeps the circuit in continuous conduction mode (CCM).