Demonstration 5

Equations used from previous lectures

Steady state

The average voltage over an inductor $V_L = 0$
The average current through a capacitor $I_c = 0$

Buck-boost and flyback converter

Continuous conduction mode (CCM)

$I_L \geq \Delta i_L/2$

Discontinuous conduction mode (DCM)

$I_L < \Delta i_L/2$

Ideal transformer

$$v = N\frac{d\phi}{dt} = L_m\frac{di_m}{dt}$$

$v_1 : v_2 = N_1 : N_2$

$v_1 i_1 = v_2 i_2$

Energy stored in an inductor

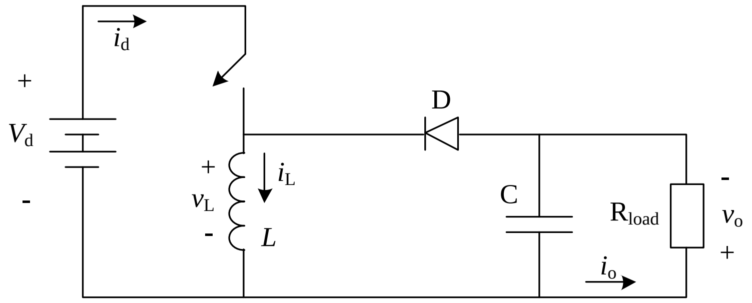
$$W = \frac{1}{2}Li^2$$

Literature: Undeland book Chapter 7, Chapter 10

Tutorial exercises

Problem 1

For a Buck-boost converter calculate the voltage ripple (Δv_o).

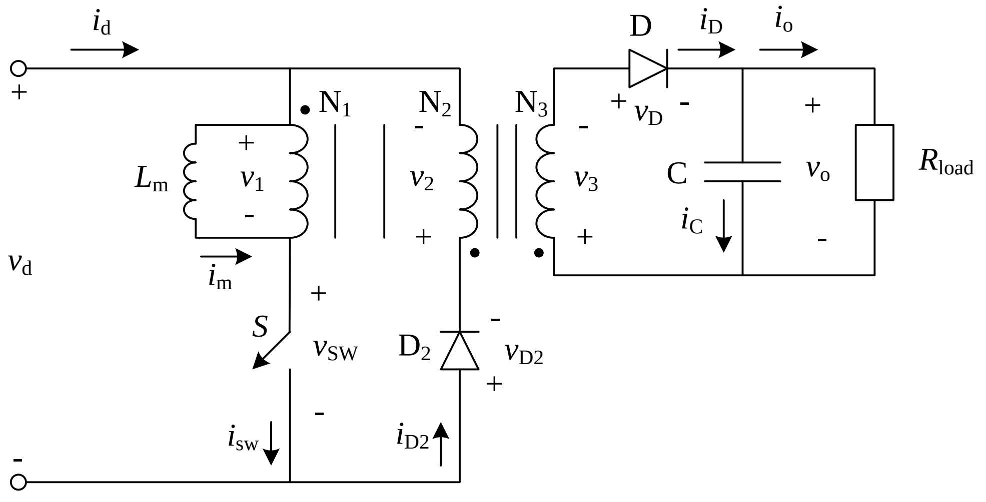


$V_d = 12V$ $\quad V_o = 15V$ $\quad f_{sw} = 20kHz$ $\quad C = 470\mu F$
$I_o = 2.5A$ $\quad L = 350\mu H$

The converter is operating in steady state and the output voltage is considered to be a pure DC-voltage.

Problem 2 (P10-2 in Undeland book)

A flyback converter, with a protective winding (N_2), has a turn ratio (N_1: N_2: N_3) equal to (1: 0.5: 1).



For DCM, Derive the voltage transfer ratio V_o/V_d in terms of the load resistance R_{load}, switching frequency (f_{sw}) transformer inductance (L_m) and duty ratio (D).

Extra problems based on problem 2

2.1. In the previous case $R_{load} = R_1, V_o = 0.5V_d, D = 0.3$. What happens if the load is changed to $R_{load} = 16R_1$ while the input voltage and the duty ratio are kept constant?

2.2. Draw the waveforms for the no load case, with $D = 0.3$.

2.3. In what way does winding N_2 and diode D_2 limit the duty ratio in steady state?

2.4. Calculate when the flyback converter changes from DCM to CCM, assume that $V_o < 2V_d$.

Self-study exercises

From Undeland book:
P10-3, P10-4