



Demonstration 3

Equations used from previous lectures

Steady state

The average voltage over an inductor $V_L = 0$

The average current through a capacitor $I_C = 0$

Step-Down Converter

Continuous conduction mode (CCM)

$$I_L \geq \Delta i_L / 2$$

Discontinuous conduction mode (DCM)

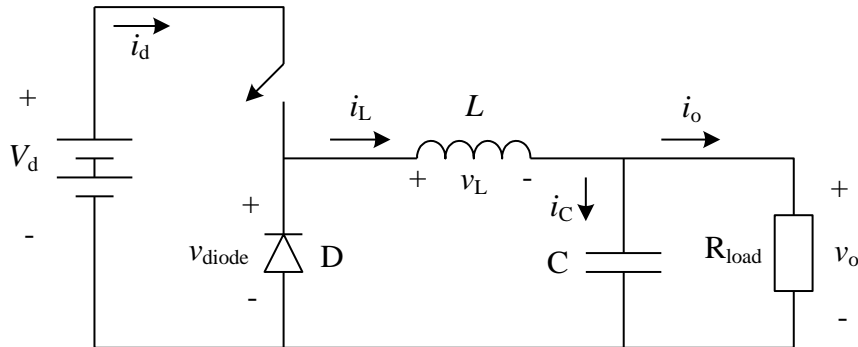
$$I_L < \Delta i_L / 2$$

Literature: Undeland book Chapter 7



Tutorial exercises

Problem 1 Buck Converters



In a step-down converter consider all components to be ideal. Let the output voltage be held constant at 5V by controlling the switch duty ratio D . The input voltage (V_d) is 30V, the switching frequency (f_{sw}) is 50 kHz, the inductance is 100 μH , the capacitance is 470 μF and the output power is 40W. Ignore the forward voltage drop on the diode.

- Plot the input current, $i_d(t)$.
- Calculate the average input current, I_d .
- For a reduction of 10% in V_d , calculate I_d .
- Calculate the output voltage ripple.
- The output power to the load is suddenly decreased to 2W. What happens in the circuit? Derive an expression for the input/output voltage ratio.
- If a more realistic circuit is considered, both the switch and the diode have a voltage drop. How does this resistance influence the expression for the input/output voltage ratio (Duty cycle) when the converter is operating in CCM?

Self-study exercises

From Undeland book:
P7-1, P7-2, P7-3