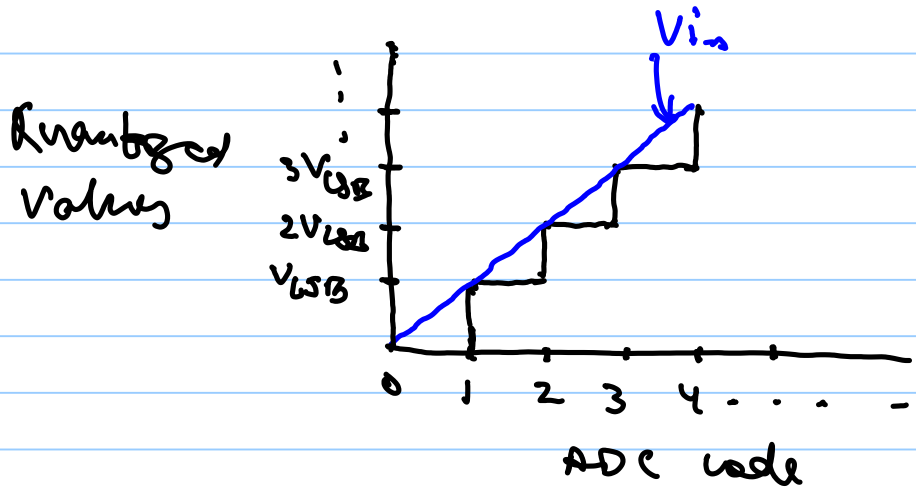
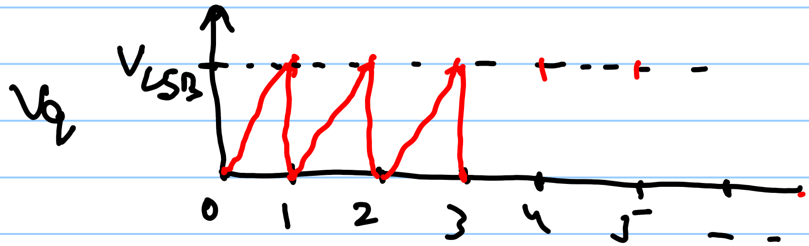
EE2019

Note Title 4/25/2019

Quantization error

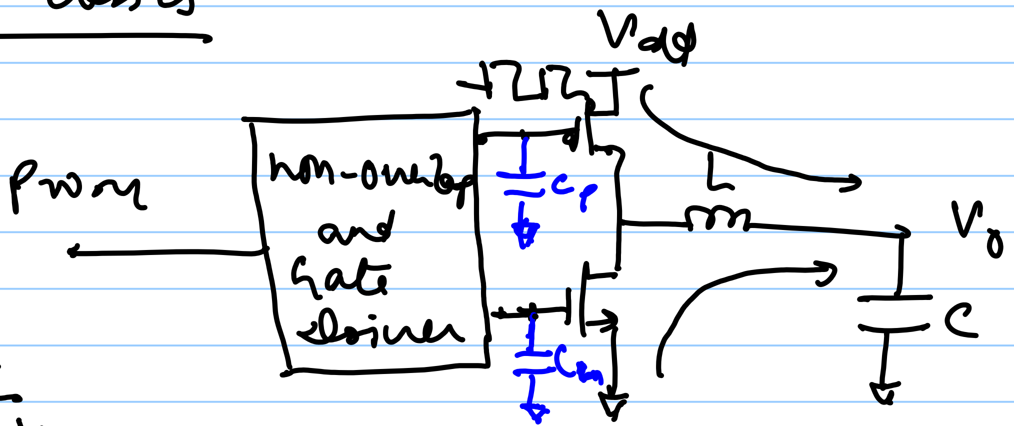


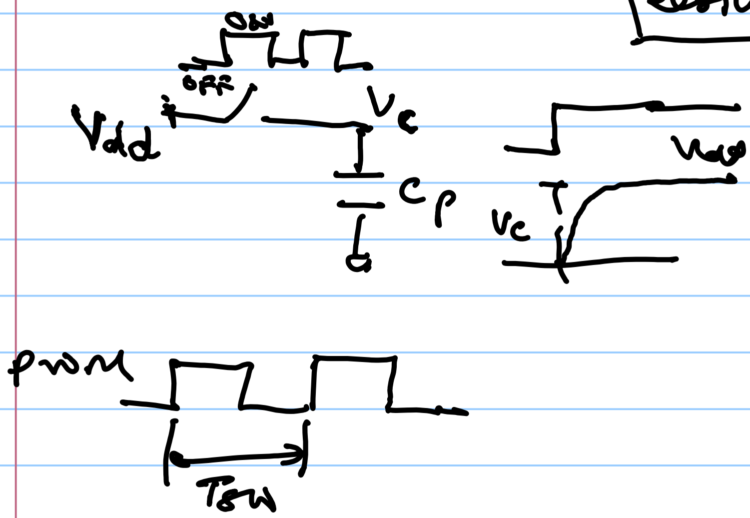
Quantization error, V_q = Vin − Quantized value



Switching Regulators

Switching Losses





$$\text{Power} = C V_{dd}^2 f_{sw}$$

$$f_{sw} = \frac{1}{T_{sw}}$$

Total switching losses (P_{loss_sw})

$$= C_p V_{dd}^2 f_{sw} + C_n V_{dd}^2 f_{sw}$$

$$= V_{dd}^2 f_{sw} (C_p + C_n)$$

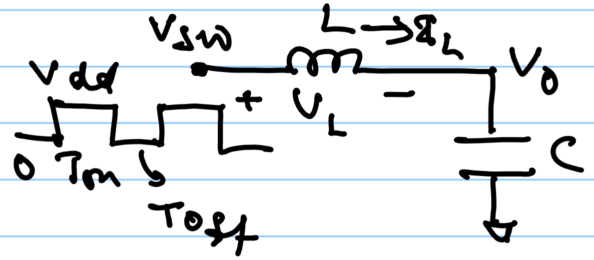
$V_{dd} = 5V$, $C_p = C_n = 1nF$

$f_{sw} = 100 KHz$

$$P_{loss\_sw} = (5)^2 (100 \times 10^3)(2 \times 10^{-9})$$

$$25 \times 10^5 \times 2 \times 10^{-9} = 5 mW$$

Ripple in Buck converter

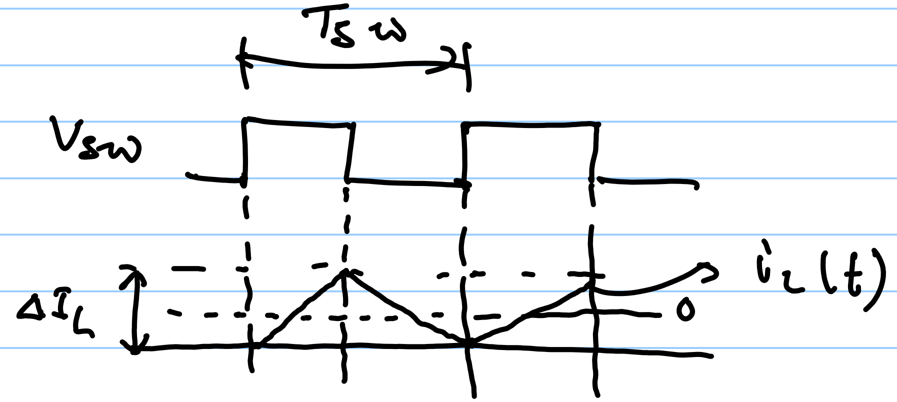


During ON time

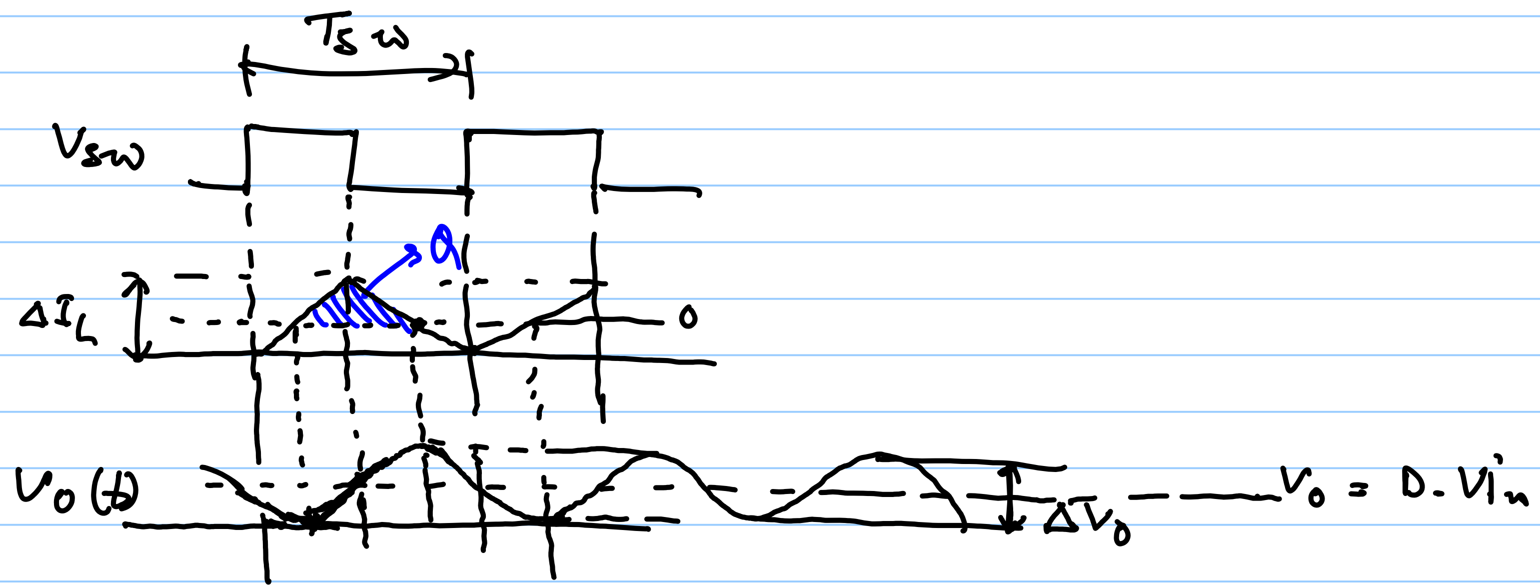
$$V_L = V_{dd} - V_0$$

$$I_L = \frac{1}{L}\int_0^{T_{ON}} V_L\,dt$$

$$= \frac{V_{in} - V_0}{L} T_{ON}$$



$$\Delta I_L = \frac{V_{in} - V_0}{L} T_{ON} = \frac{V_{in} - V_0}{L} D \cdot T_{SW}$$



ΔV_o = output ripple voltage

$$V_o(t) = V_o(dc) + \frac{1}{C}\int i_L(t)\,dt$$

Total charge going into the capacitor.

Q = area of triangle

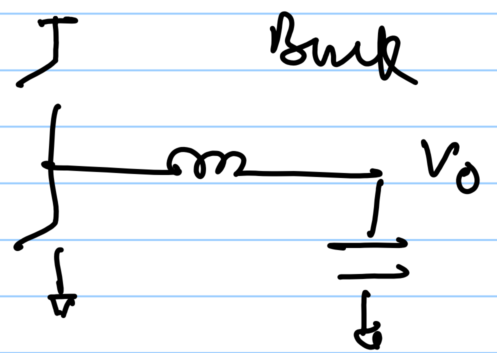
$$= \frac{1}{2} \times \frac{T_{sw}}{2} \times \frac{1}{2}\left(\frac{V_{in} - V_0}{L}\right) D \cdot T_{sw}$$

$$= \frac{1}{8} T_{sw}^2 \frac{V_{in}(1-D)D}{L}$$

$$\Delta V_0 = \frac{Q}{C} = \frac{1}{8} \frac{V_{in} \cdot D \cdot (1-D)}{LC f_{sw}^2}$$

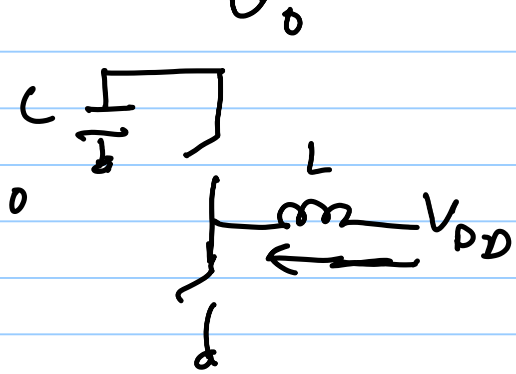
Boost converter (step-up)

$V_0 > V_{DD}$



$V_0 = D \cdot V_{DD}$

flip V_{DD} & V_0



$V_{DD} = D \cdot V_0$

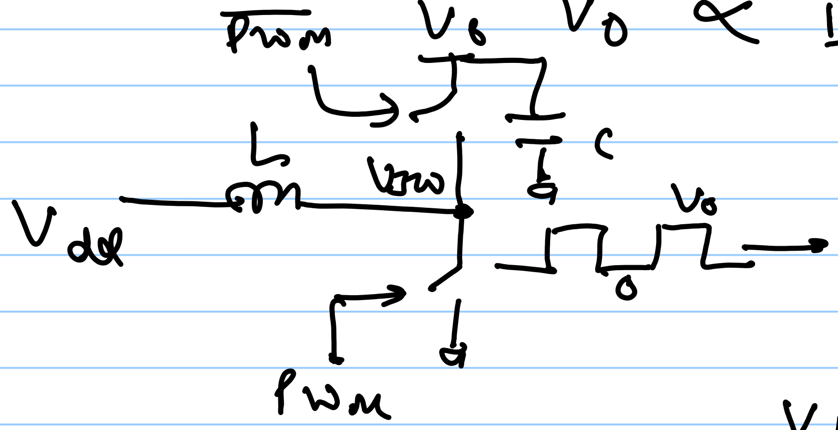
$V_0 = \frac{V_{DD}}{D}$

$D \rightarrow 1 - D$

$$V_o = \frac{V_{DD}}{1 - D}$$

$V_o \geq V_{DD}$

$V_o \propto D$



$V_{sw}(\text{avg}) = (1-D)\,V_o$

$V_{dd} - (1-D)\,V_o = 0$

$$\Rightarrow \quad V_o = \frac{V_{dd}}{1-D}$$

for ideal converter

$$P_{in} = P_0$$

$$V_{dd} \cdot I_{dd} = V_0 \cdot I_0 = \frac{V_{dd}}{1-D} \cdot I_0$$

$$\boxed{I_{dd} = \frac{I_0}{1-D}}$$