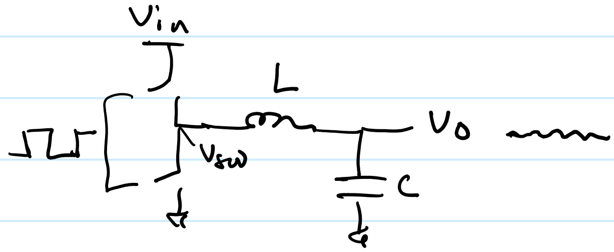
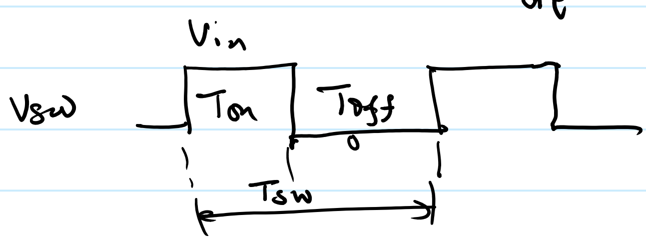
Inductor Volt-Second Balance



Inductor $\rightarrow$

$$V_L = L\frac{di}{dt} \Rightarrow i = \frac{1}{L}\int V_L \, dt$$



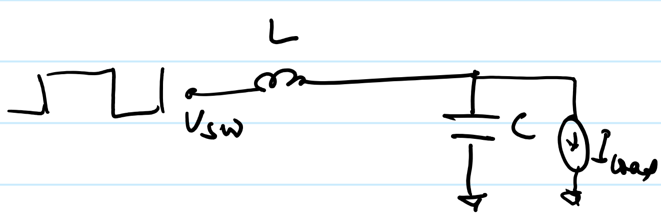
$$V_L \cdot D \cdot T_{sw} + V_L (1-D) T_{sw} = 0$$

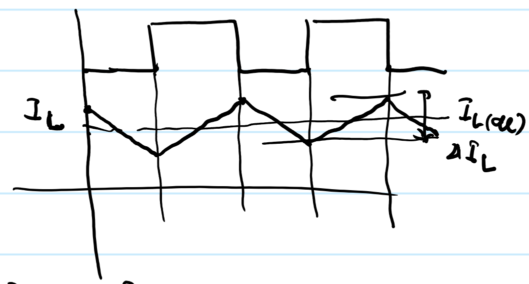
Volt-second balance

$$(V_{in} - V_o) D + (-V_o)(1-D) = 0$$

$$D.V_{in} - \cancel{D.V_o} - V_o + \cancel{V_o D} = 0$$

$$\Rightarrow \boxed{V_o = D \cdot V_{in}}$$





$$I_L = I_L(dc) + \Delta I_L$$

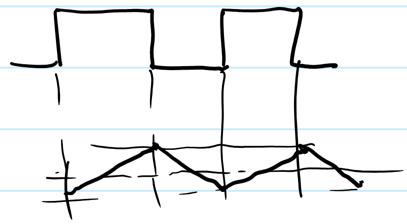
$$I_L(dc) = I_{Load}$$

Output Ripple

$$V_L = L\frac{di}{dt}$$

during T_{on}

$$\frac{(V_{in} - V_o)}{L} \times T_{on} = \Delta i_L$$

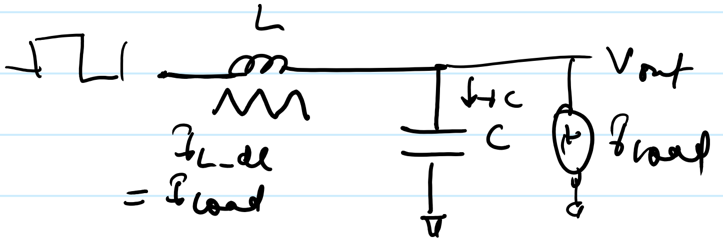


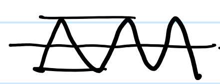
during T_{off}

$$\frac{-V_o}{L} \times T_{off} = \Delta i_L$$

$$= -\frac{D \cdot V_{in}\,(1-D)\,T_{sw}}{L} = -\frac{D\cdot(1-D)}{L} V_{in}\,T_{sw}$$

$$\therefore \frac{(V_{in} - D\cdot V_{in})}{L} D\cdot T_{sw} = \frac{D(1-D)}{L} \cdot V_{in}\,T_{sw}$$





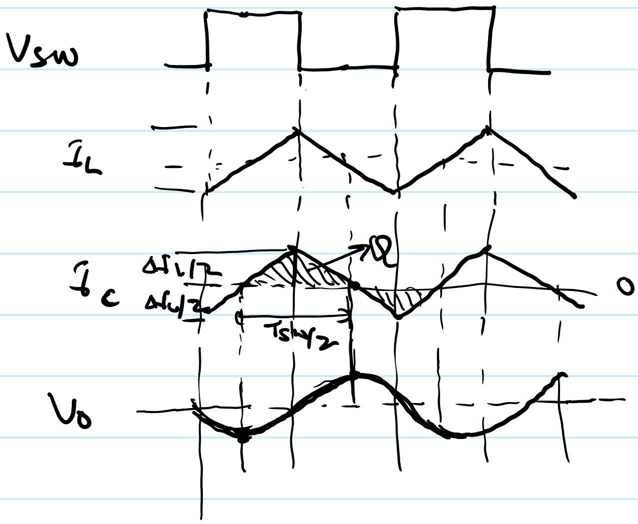
$$i_c = \Delta i_L$$

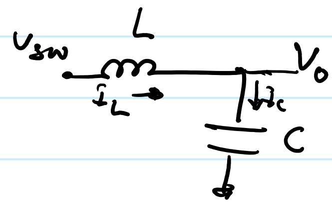
Average current through Cap = 0
if Vout = constant

$$i = C\frac{dV}{dt}$$

$$V = \frac{1}{C}\int i\,dt$$

Output Ripple (contd.)





$$\boxed{\Delta I_L = \frac{V_{in}\, D(1-D)}{L}\, T_{sw}}$$

$$\text{Area of } \Delta = Q = \frac{1}{2}\,\text{base} \times \text{ht}$$

$$= \frac{1}{2} \times \frac{T_{sw}}{2} \times \frac{\Delta I_L}{2}$$

$$= \frac{1}{8} T_{sw} \times \Delta I_L = \frac{\Delta I_L}{8 \cdot F_{sw}}$$

$$Q = C\Delta V \Rightarrow \Delta V = \frac{Q}{C}$$

$$\Delta V = \frac{\Delta I_L}{8 \cdot F_{sw} \cdot C} = \frac{V_{in}\, D(1-D)}{8 \cdot F_{sw}^2 \cdot C L}$$

output ripple.

$$\boxed{\Delta V = \frac{D(1-D)}{8 \cdot F_{sw}^2 \cdot C L}\, V_{in}}$$

by specification

by design