ECEN 4797/5797

Introduction to Power Electronics

Lecture #3

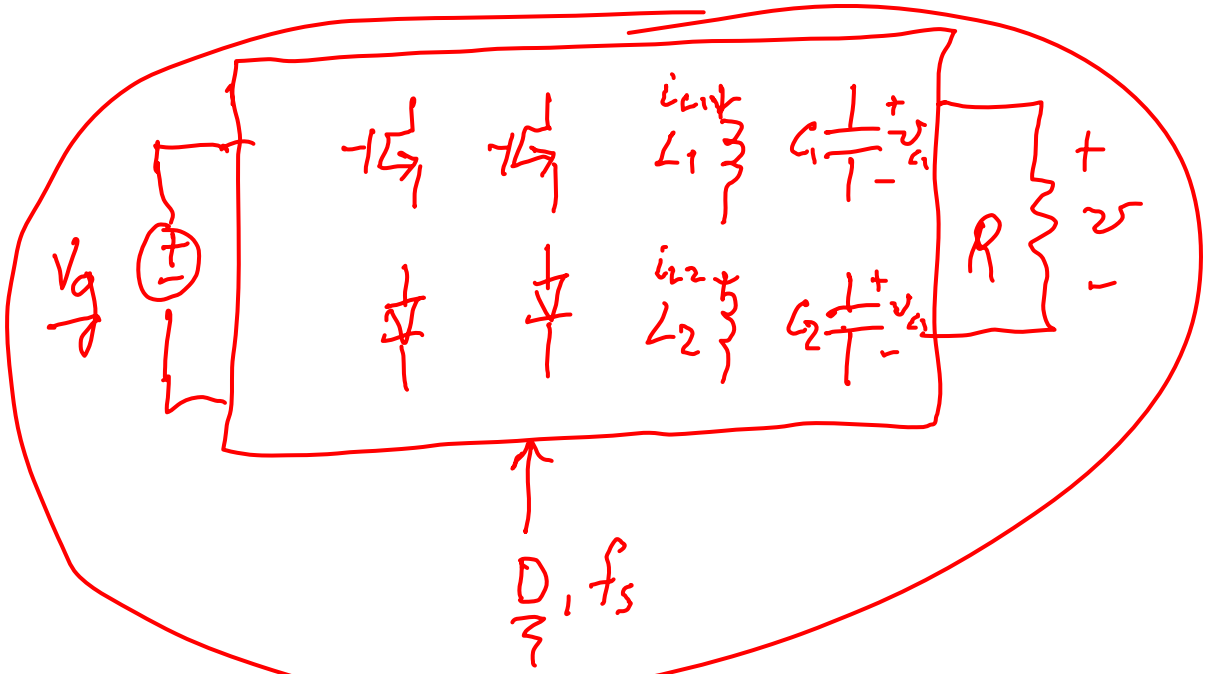
Friday, August 28, 2009

Steady State Converter Analysis

(Chapter 2, continued)

Prof. Regan Zane

Steady-state, equilibrium operation, DC-DC SMPS



States: i_{Li}, v_{Ci}

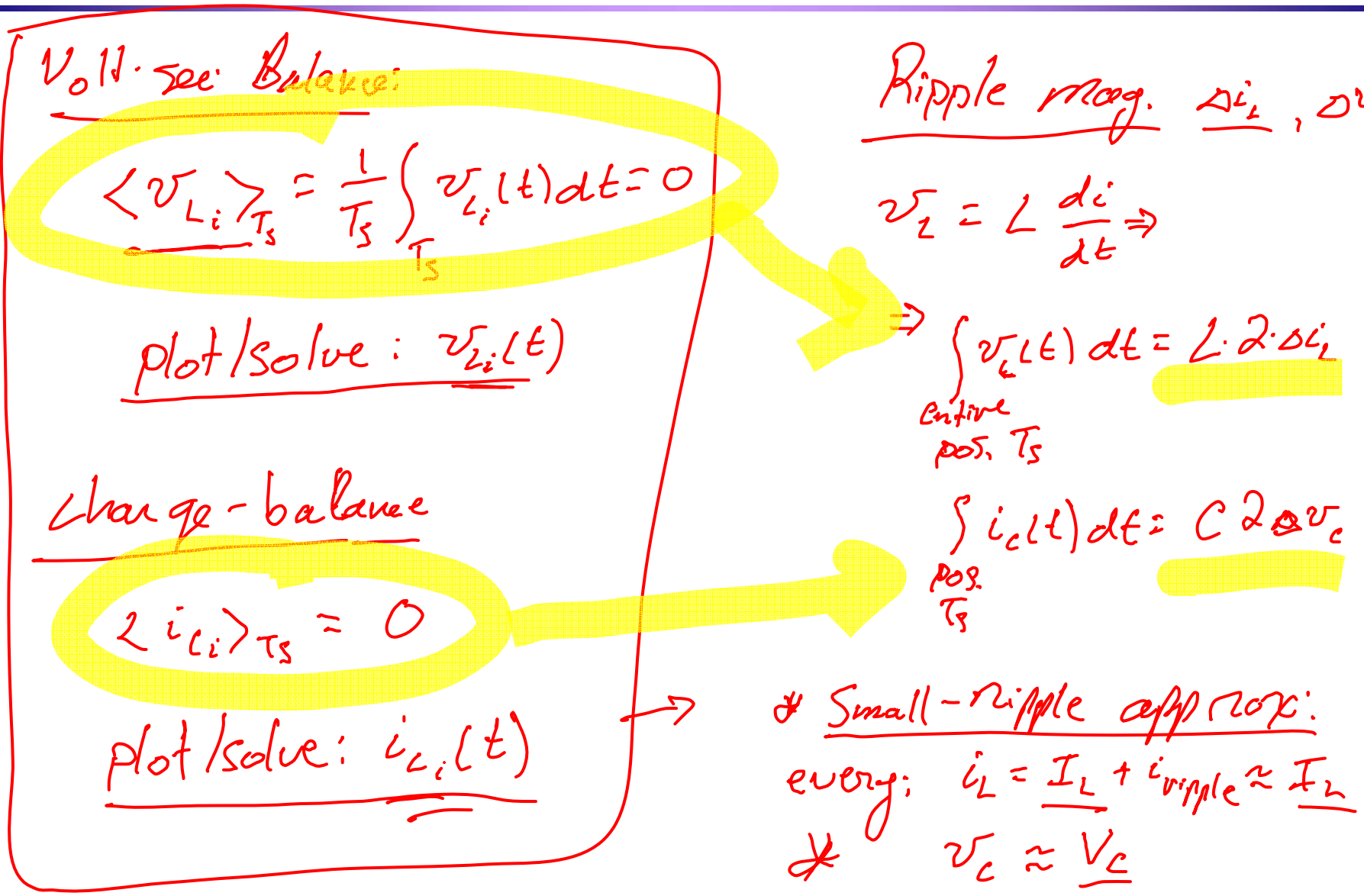
Goal:

- Solve DC: I_{Li}, V_{Ci}
- Ripples: Δi_{Li}, Δv_{Ci}

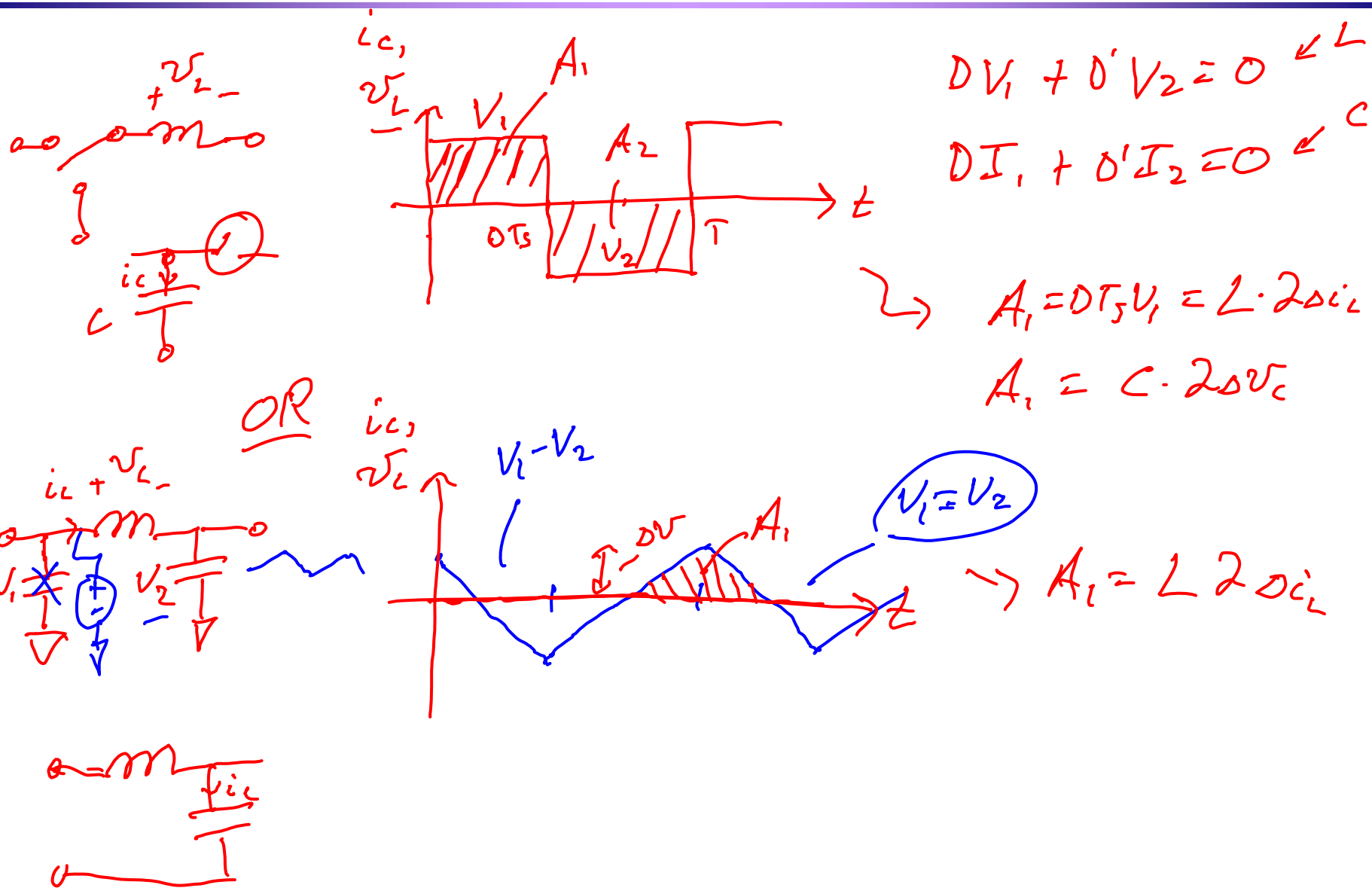
⇒ All signals

- Conversion Ratio: M(D)
- Design/Select all L_i's, C_i's.
- Select Switches: All comp. stress & ratings.

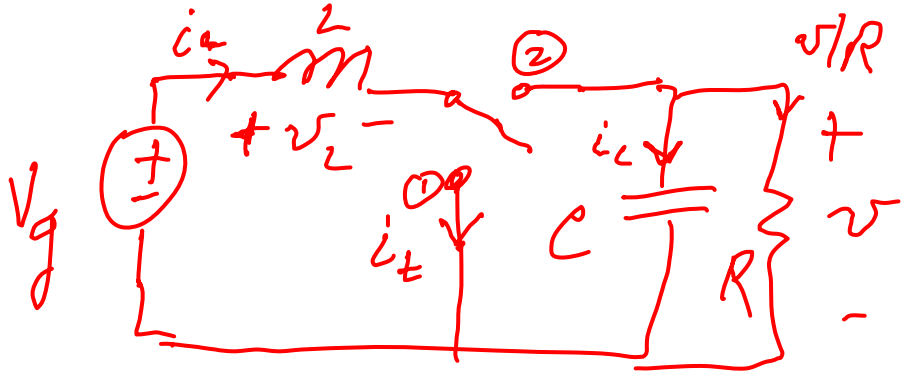
Volt-sec & charge balance, ripple magnitudes

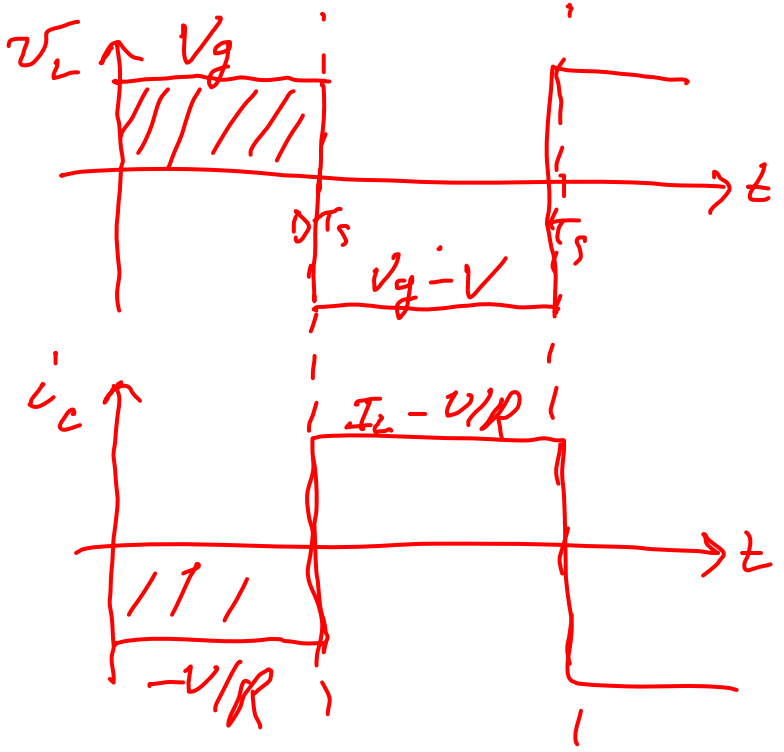


Inductor voltage & capacitor current plots



Boost Example





- $i_L \approx I_L$, $v \approx V$

v_L: $DV_g + D'(V_g - V) = V_g - D'V = 0$

$$\Rightarrow \boxed{\frac{V}{V_g} = M(D) = \frac{1}{D'} = \frac{1}{1-D}}$$

i_C: $-\frac{DV}{R} + D'\left(I_L - V/R\right) = D'I_L - \frac{V}{R} = 0$

$$\Rightarrow \boxed{I_L = \frac{1}{D'} \cdot \frac{V}{R} = \frac{1}{D'^2} \cdot \frac{V_g}{R}}$$

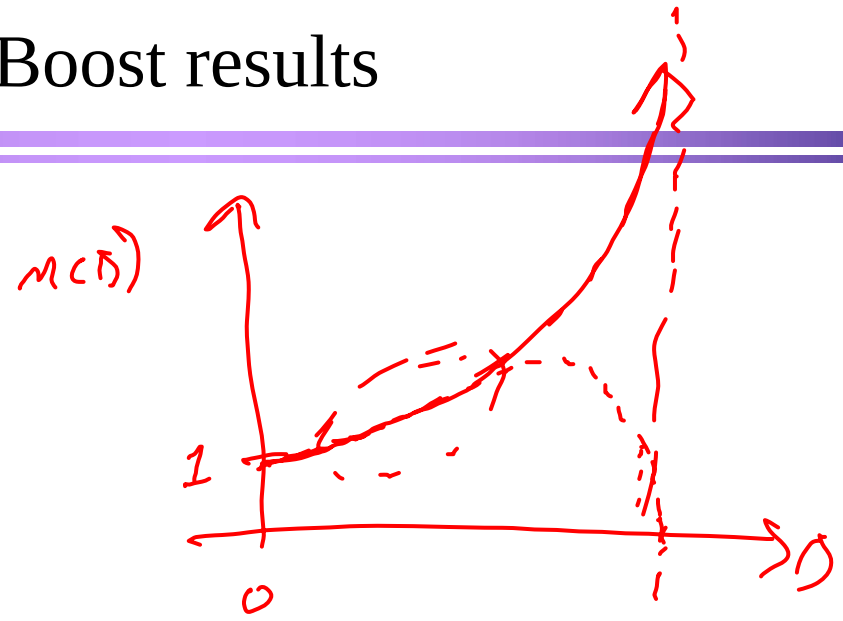
$$\boxed{DT_s V_g = L \cdot 2\Delta i_L}$$

$$\boxed{\frac{-V}{R} DT_s = -C\, 2\Delta v}$$

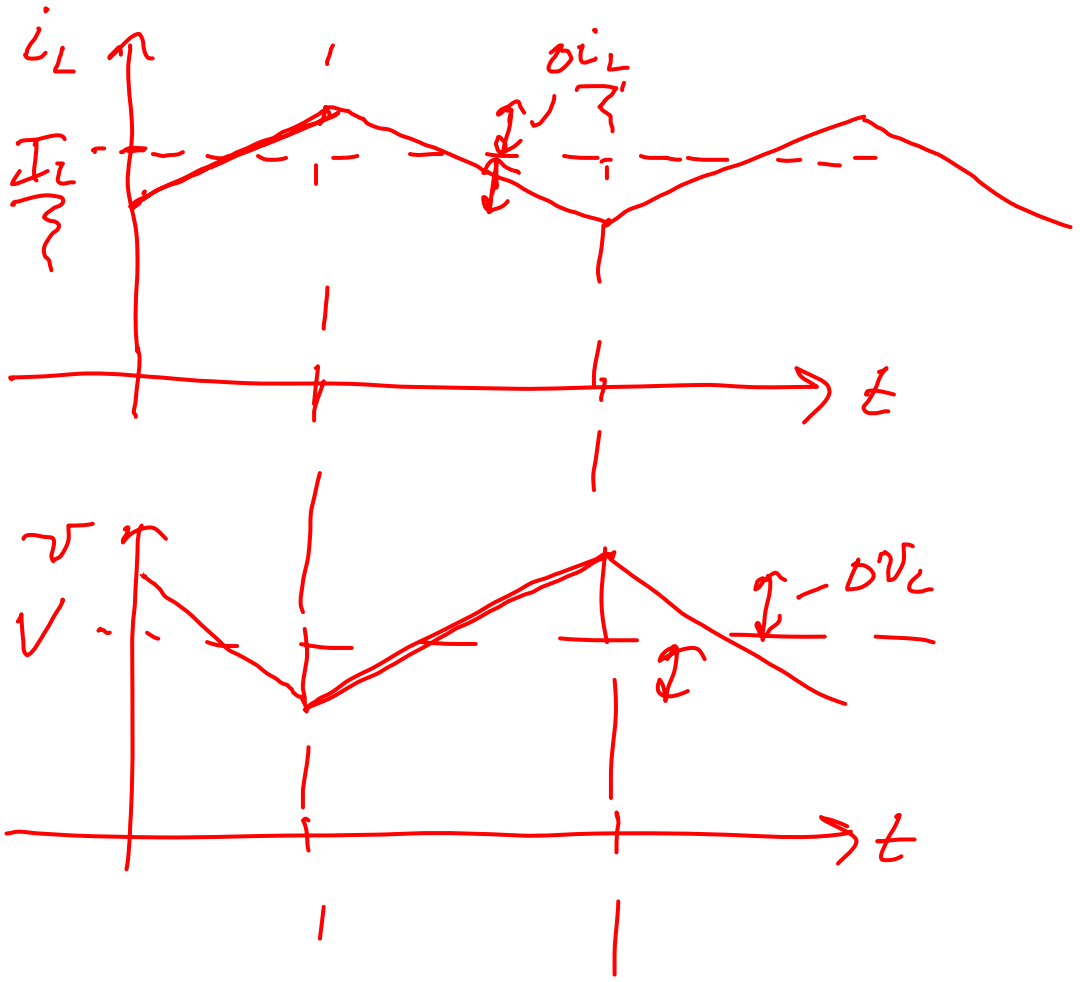
Boost results

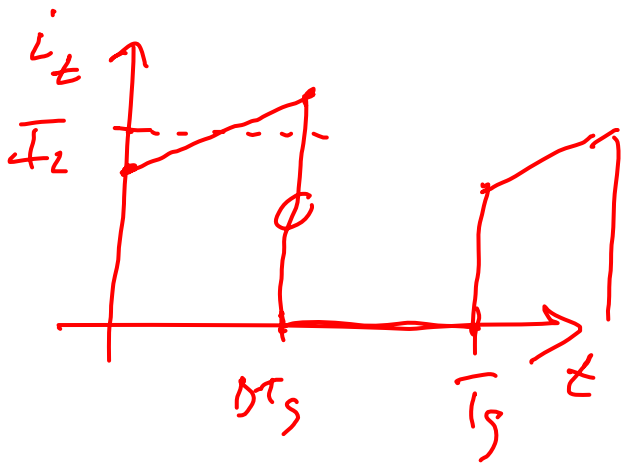
$$M(D) = \frac{1}{1-D}$$

$$I_L = \frac{V_g}{R} \cdot \frac{1}{(1-D)^2}$$

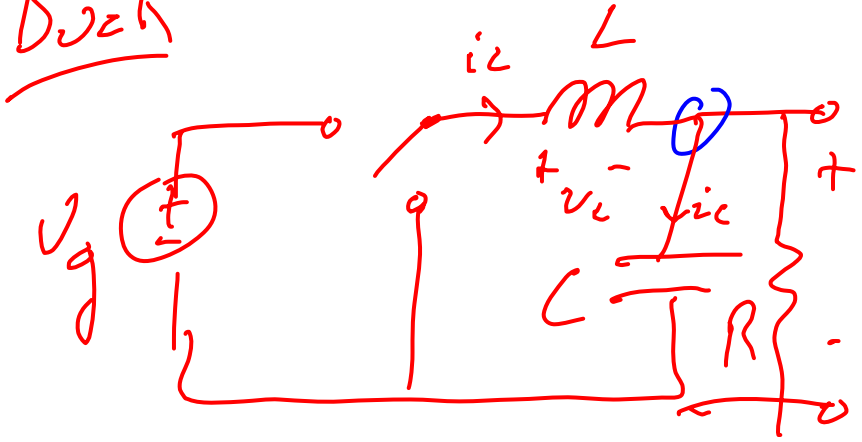


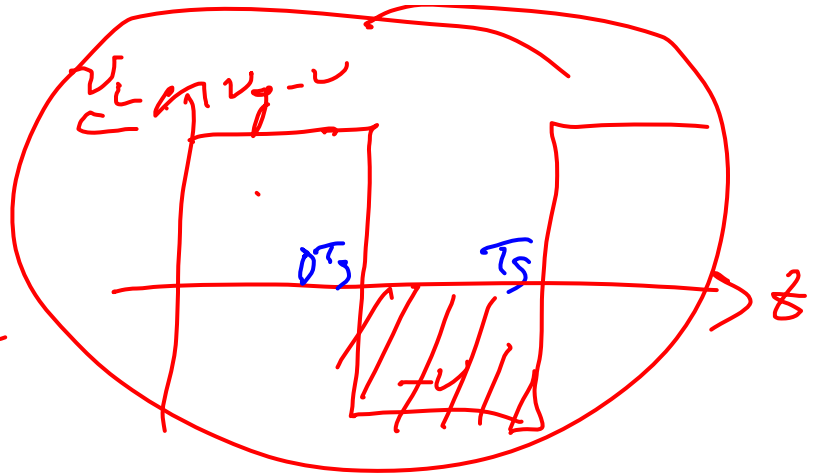
Boost results





Buck

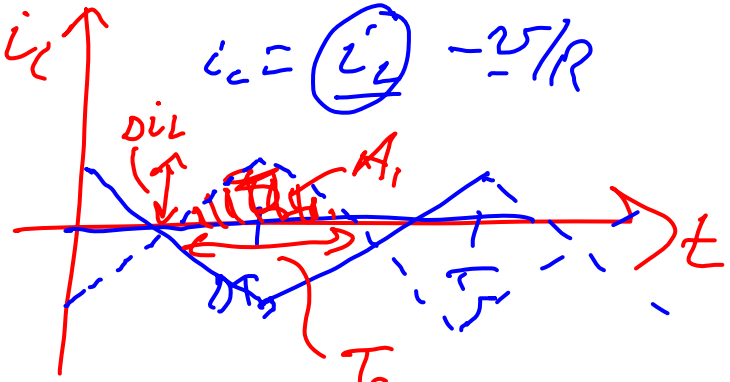




- $i_L \approx I_L$
- $v \approx V$

$$I_L = \frac{V}{R}$$

$$\Delta i_L = \frac{V D' T_s}{2L}$$



$$A_1 = \frac{1}{2} \cdot \frac{T_s}{2} \cdot \Delta i_L = C \cdot 2\Delta v_C$$

$$+V D' T_s = \pm L \cdot 2\Delta i_L$$