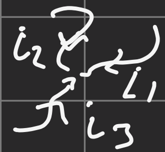
Dc-Dc converter Basics:

KCL ≡ Kershof current law  $\Rightarrow \sum_j i_j = 0$

what will happen if we Take Time avg current $\equiv \langle \sum_j i_j \rangle = 0$

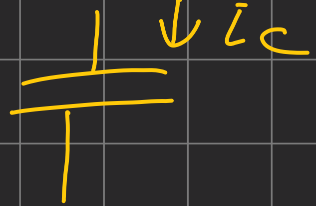
well because we know That avg over Time ≡ integral

we can change The order of The integral $\Rightarrow \sum_j \langle i_j \rangle = 0$

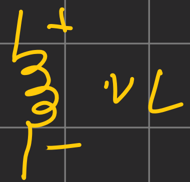
$\Rightarrow$ average current into a node $= 0$ $\Rightarrow$ make sense

same For KVL $\sum_k \langle v_k \rangle = 0$ sumation of avg voltage in Terminals around a loop $= 0$

PSS ⇒ Periodic Steady State.

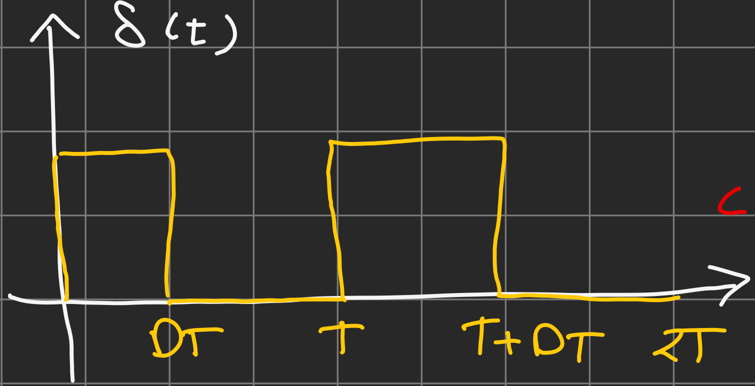


$$\langle i_c \rangle = 0 = C\boxed{\frac{dv}{dt}} \rightarrow 0 \text{ in steady state}$$



$$\langle v_L \rangle = 0 = L\boxed{\frac{di}{dt}} \rightarrow 0 \text{ in steady state}$$

Periodic switching:

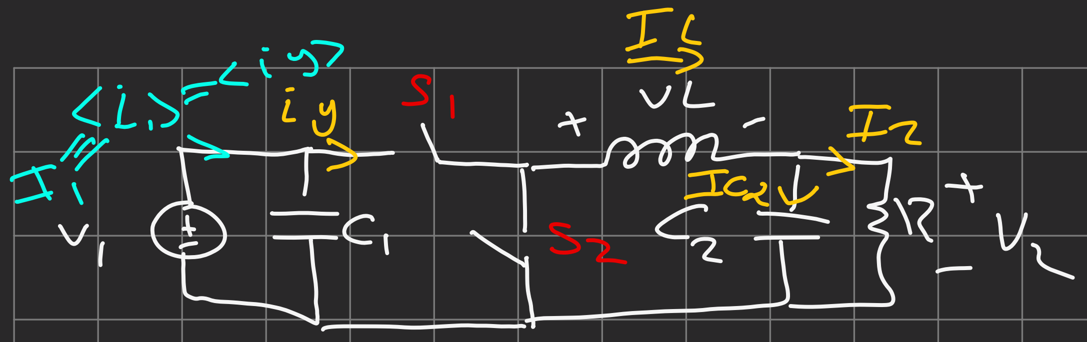


$$V_x - V_L - V_2 = 0$$

$$\langle V_x \rangle - \underbrace{\langle V_L \rangle}_{\rightarrow 0 \text{ in PSS}} - \langle V_2 \rangle = 0$$

$$\langle V_2 \rangle = \langle V_x \rangle$$

$$\boxed{\langle V_x \rangle = D \cdot V_1 = \langle V_2 \rangle = D \cdot V_1} \Rightarrow (1)$$



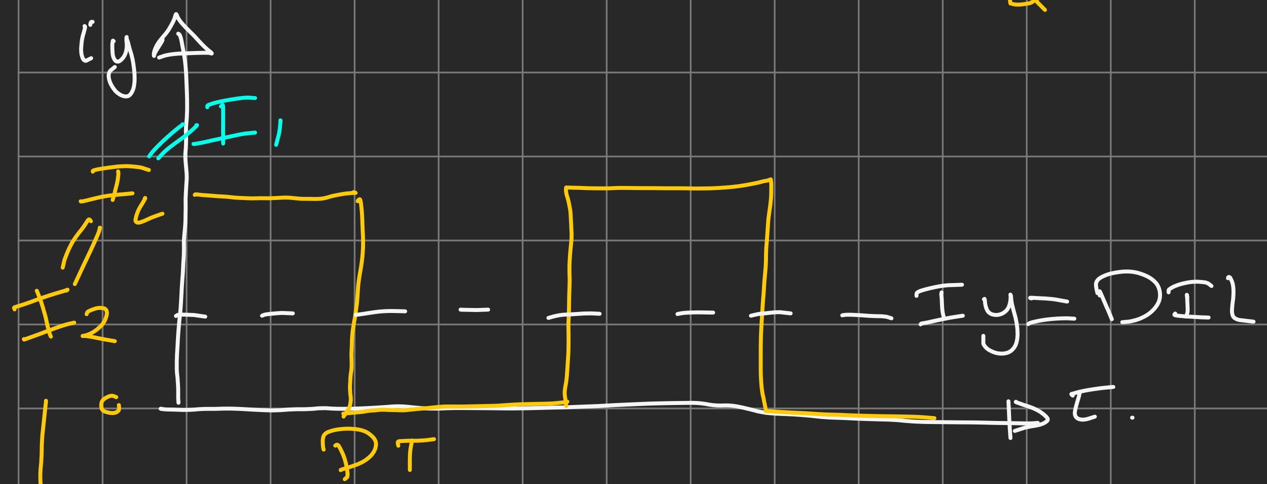
⇒ assumption inductor & capacitor are very big #

zero voltage ripple

zero current ripple

$i_L(t) \simeq I_{L,DC}$

$V_1(t) = V_{1,DC}$ $\quad V_2(t) = V_{2,DC}$



why $\langle I_L\rangle = \langle I_2\rangle + \langle \cancel{I_c}\rangle$ → 0 at PSS

$\langle I_L\rangle = \langle I_2\rangle$

$$\boxed{I_1 = D I_2} \Rightarrow ②$$

$$V_2 = D V_1 \Rightarrow ✓$$

$$P_{out} = V_2 \cdot I_2 = D V_1 \cdot \frac{I_1}{D} = V_1 I_1$$

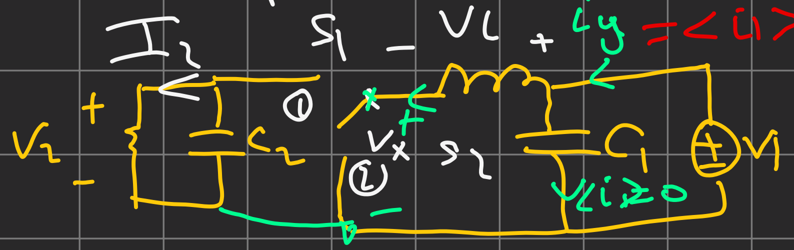
Power conservation #
No power loss in converter

This converter can step down voltage => [Buck] #

<u>how To Implement:</u>

in off state the inductor want to resist the sudden change so it generate a back EMF => voltage spike => old / new
reverse / forward

Diode provide an alternative path for current to flow

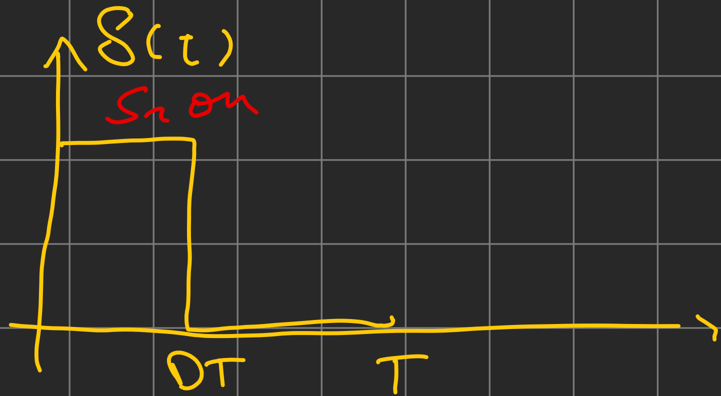


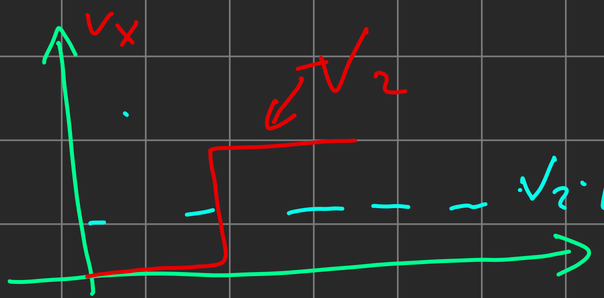
$$\langle V_1 \rangle - \underbrace{\langle V_L \rangle}_{\to 0} - \langle V_x \rangle = 0$$

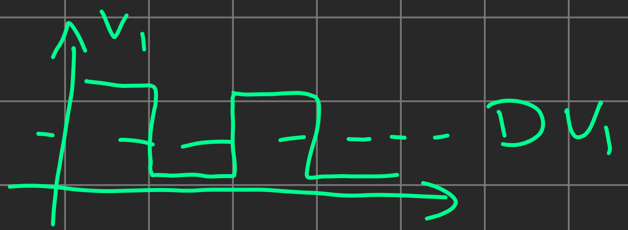
$$\langle V_1 \rangle = \langle V_x \rangle$$

$$V_x = \cancel{V_1} = [1-D]\, V_2$$

$$\boxed{V_2 = \frac{V_1}{1-D}}$$

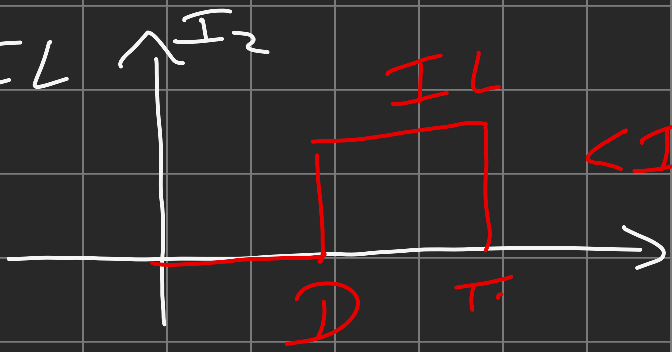






$V_1 < V_2 < \infty \implies$ Boost DC-DC converter

$I_1 = I_L$



$\langle I_1 \rangle = \langle I_2 \rangle$

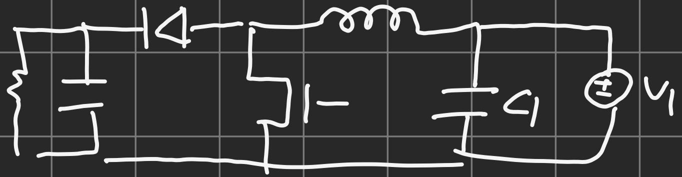
$\Rightarrow I_1[1-D]$

$= I_2$

$I_2 = [1-D]\, I_1$

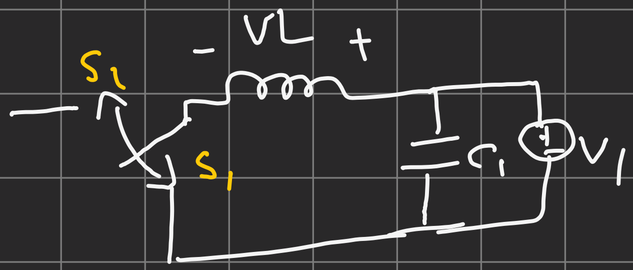
$V_2 = \dfrac{V_1}{1-D}$

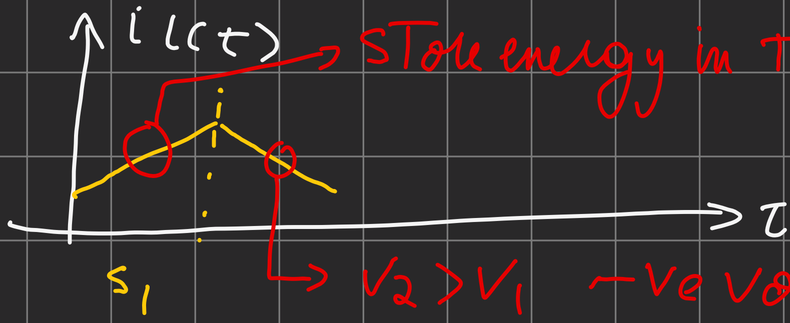
Boost converter:



How is IT really working?

well, let's make some assumption First $\Rightarrow$ inductor is not very big so





$\rightarrow$ Store energy in the inductor

$\rightarrow$ $V_2 > V_1$ $-$ve voltage drop on inductor

inductor is Discharged in the output