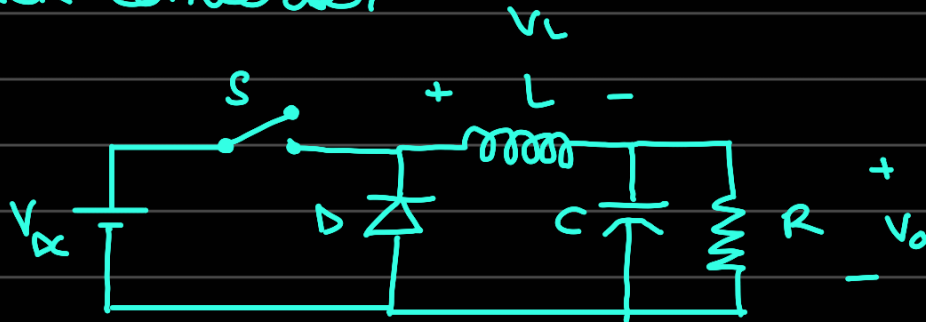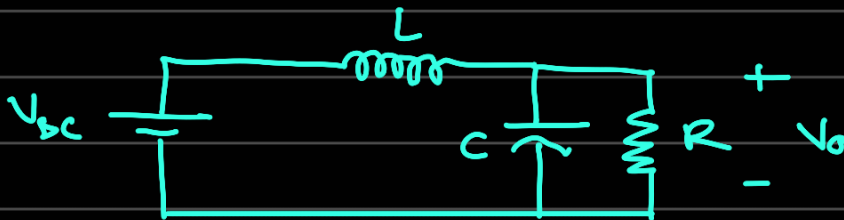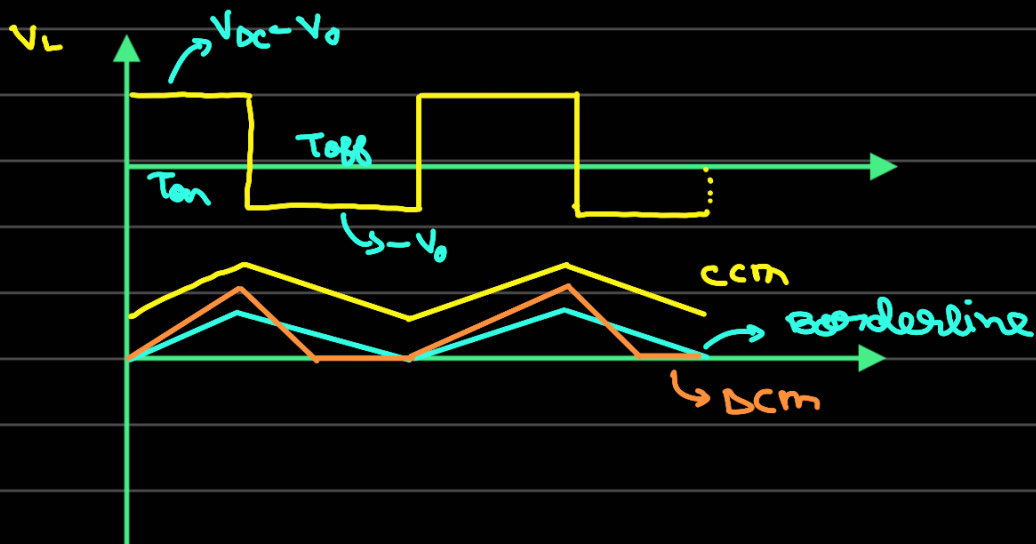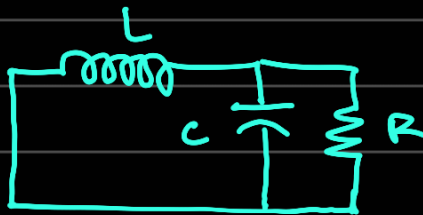→ Buck converter —

When S is ON:

When S is OFF

$\langle V_L \rangle = 0$ (whatever it stores, it gives back)

$$\Rightarrow (V_{DC} - V_0)(T_{on}) = V_0 \, T_{off}$$

$$\Rightarrow (V_{DC} - V_0) \, DT = V_0 (1-D) T$$

$$\Rightarrow \quad V_{DC} DT - V_0 DT = V_0 T - V_0 DT$$

$$\Rightarrow \quad V_0 = D V_C$$
$$\qquad \quad \hookrightarrow \text{ duty cycle}$$

Border current

(Given, Peak current $= I_{max}$)

$$V_L = \frac{L \, di}{dT}$$

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

$$= \begin{cases} \dfrac{V_{dc} - V_0}{L} \, t & , \quad 0 \leq t \leq DT \\[4mm] \dfrac{V_0}{L} (T - t) & , \quad DT < t \leq T \end{cases}$$

$$i_{LB} = \frac{1}{2} \, i_p = \frac{1}{2} \, \frac{(V_{DC} - V_0)}{L} \, DT$$

$$\qquad \qquad = \frac{DT}{2} \, \frac{V_{DC} - V_0}{L}$$

$$V_0 = D V_{DC}$$
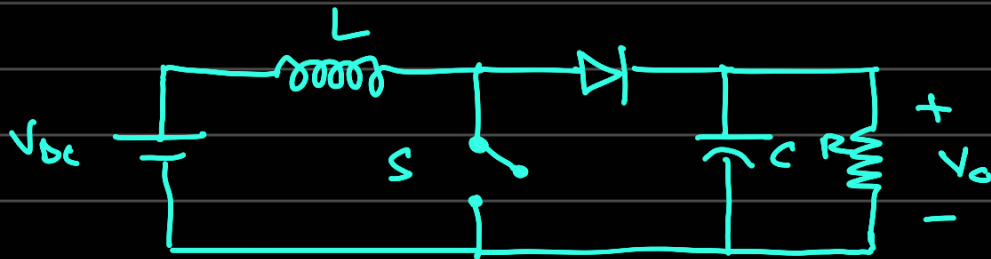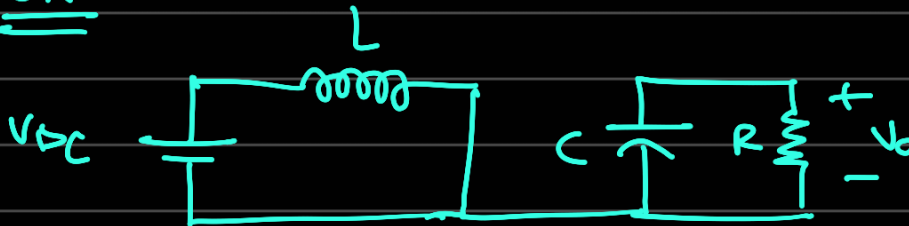$$\text{so} \quad i_{LB} = \frac{T V_{DC}}{2L} \, D(1 - D)$$

$\rightarrow$ Boost converter —

Redraw Buck :

Boost :

ON :

OFF :