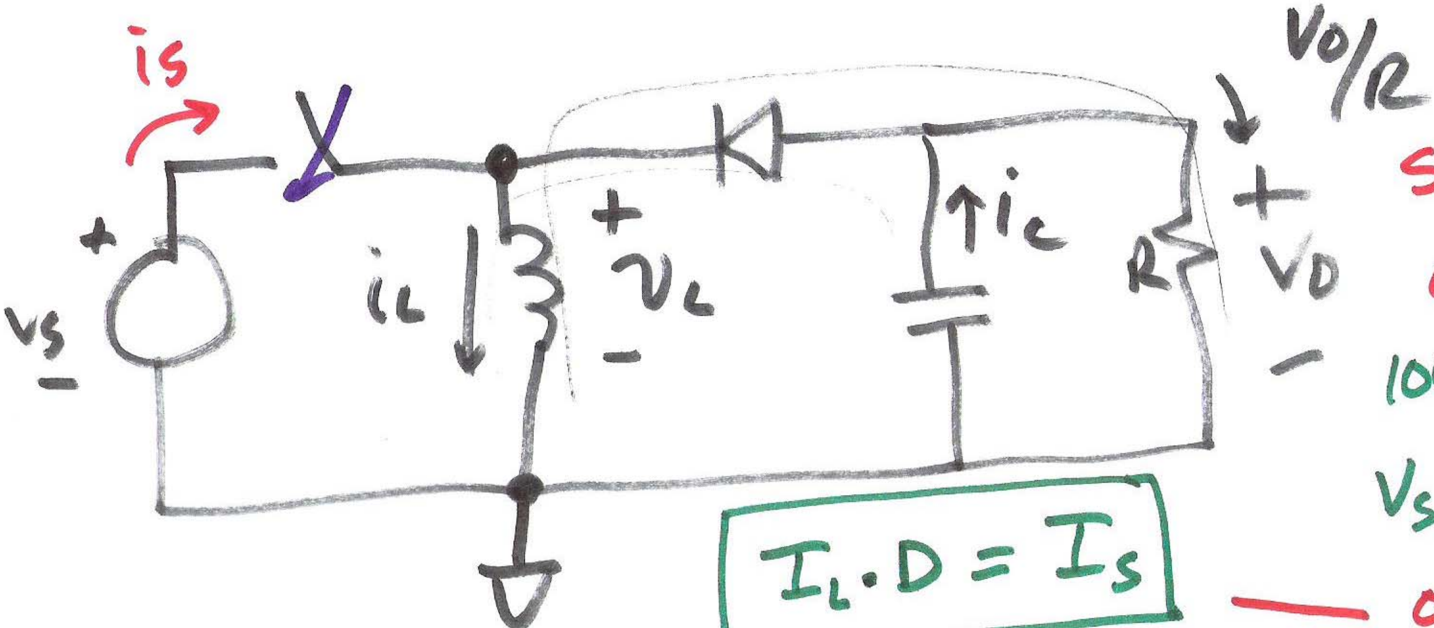
ECE 5/472 POWER Electronics

BOISE STATE UNIVERSITY

Lecture 7 Sept. 13, 2011



Switch closed

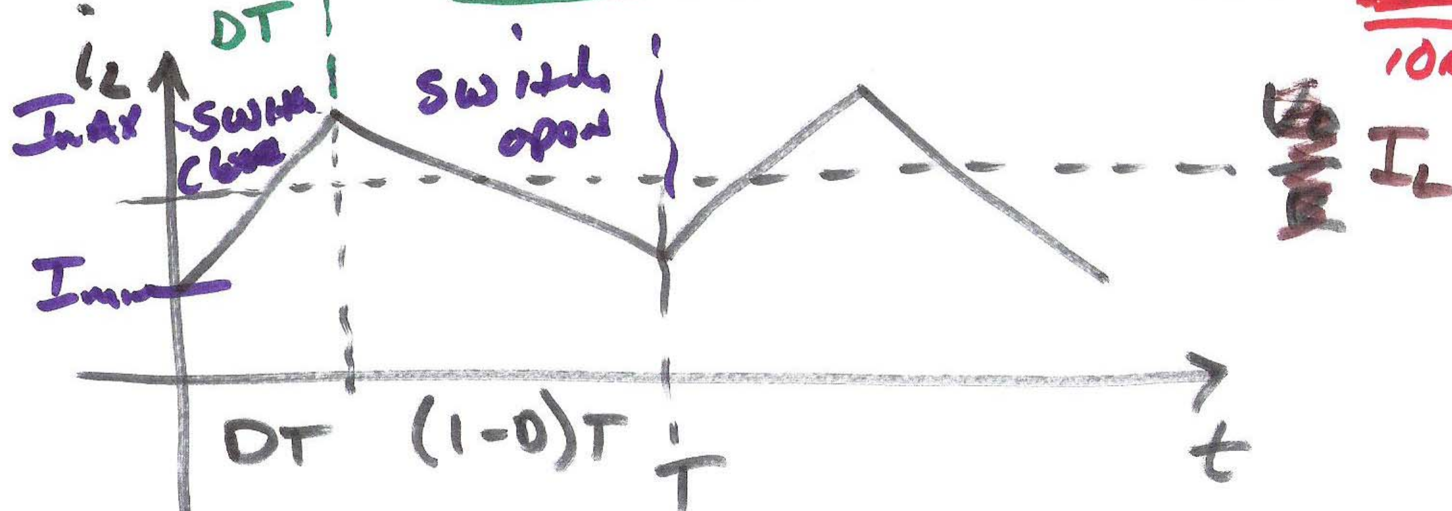
$i_s = i_L$

100% eff. conv.

$V_s \cdot i_s = \frac{V_o^2}{R}$

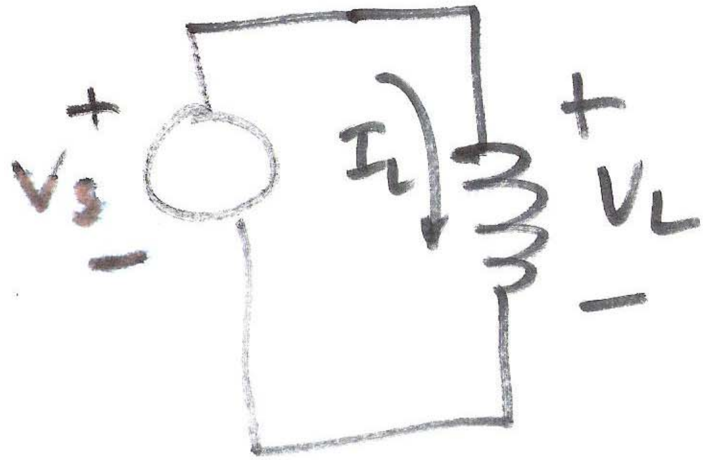
$$I_L \cdot D = I_S$$

0→15 3.3A / 10A



1)

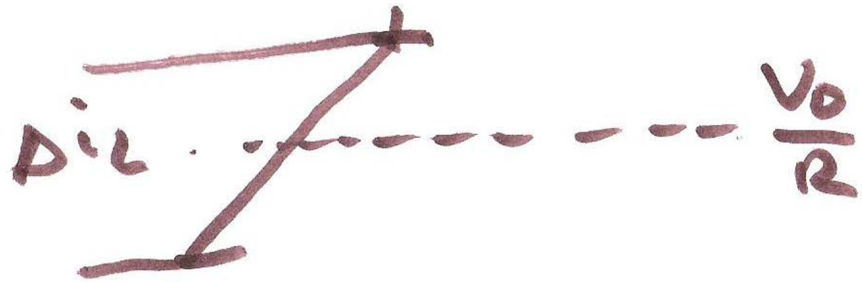
switch closed



$$V = L \frac{di_L}{dT}$$

$$\frac{V_s}{L} = \frac{\Delta i_L}{D \cdot T}$$

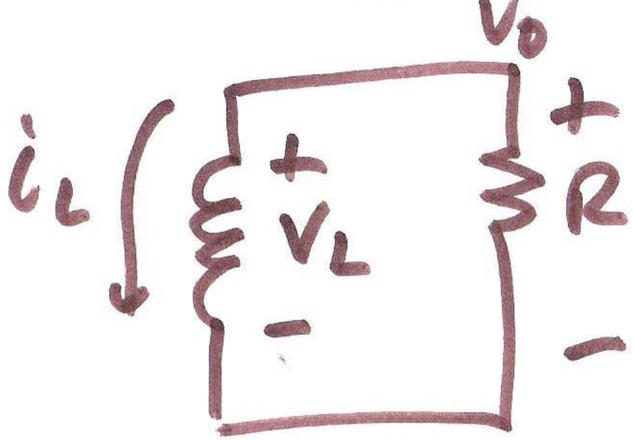
$$\boxed{\Delta i_L = \frac{D \cdot T \cdot V_s}{L}} = \frac{D V_s}{f \cdot L}$$



$$\frac{D \not{T} \cdot V_s}{\not{L}} = \frac{V_o (1-D) \not{T}}{\not{L}}$$

$$\boxed{-V_o = \frac{D}{1-D} \cdot V_s}$$

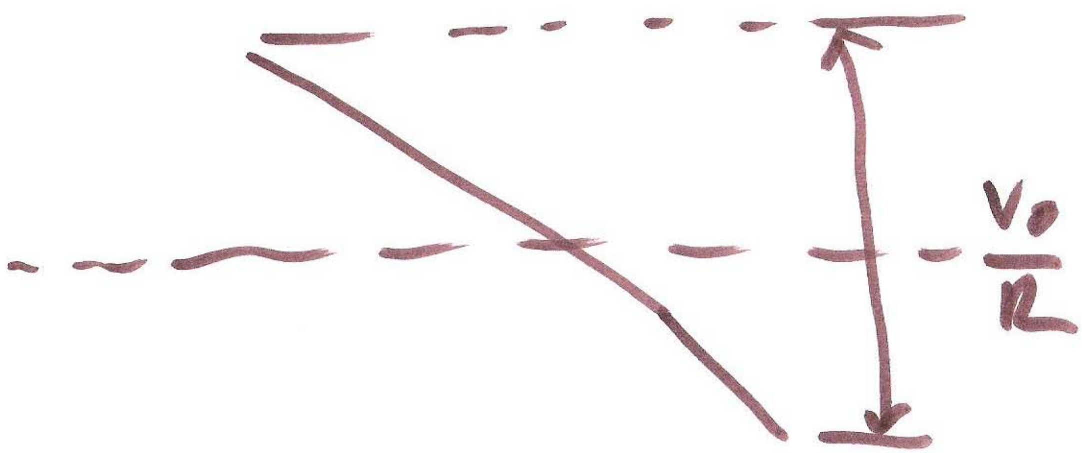
Switch open



$$V = L\cdot\frac{di}{dt}$$

$$\frac{V_0}{L} = \frac{\Delta i_L}{(1-D)T}$$

$$\boxed{\Delta i_L = \frac{V_0\cdot(1-D)T}{L}}$$



3)

$5 = \frac{D}{1-D} \cdot 10$

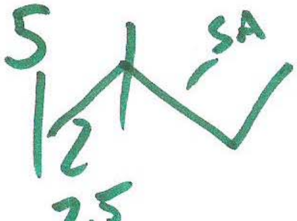
$\frac{D}{1-D} = \frac{1}{2}$

$D = \frac{1}{2} - \frac{1}{2}D \rightarrow \frac{3}{2}D = \frac{1}{2}$

$V_S = 10$ $\quad D = \frac{1}{3}$

$V_O = -5$

$D =$



$$\frac{V_O^2}{R} = V_S \cdot I_S = V_S \cdot D \cdot I_L$$

$$I_L = \frac{V_O^2}{R \cdot V_S \cdot D}$$

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

$I_L = 7.5$

$\frac{3.3}{.67^2} =$ [illegible]

$\frac{10 \cdot .33}{(1-.33)^2}$

$R = 1$

Minimum/max

$$I_{max} = I_L + \frac{\Delta i_L}{2} = \frac{V_S \cdot D}{R(1-D)^2} + \frac{DTV_S}{2L}$$

$$I_{min} = I_L - \frac{\Delta i_L}{2} = \frac{V_S \cdot D}{R(1-D)^2} - \frac{DTV_S}{2L}$$

4)

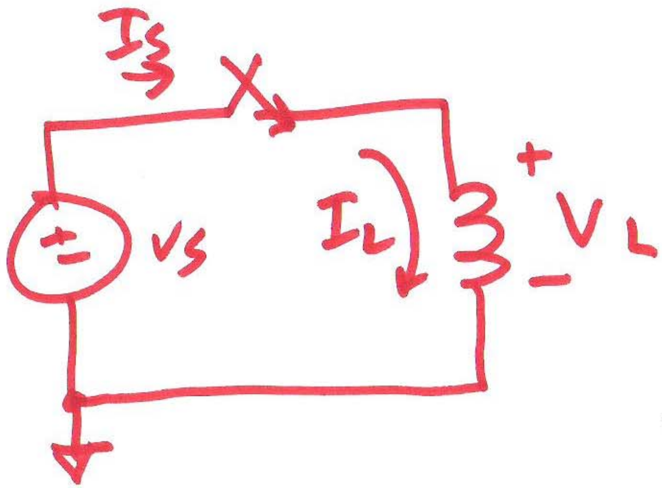
Minimum inductor value

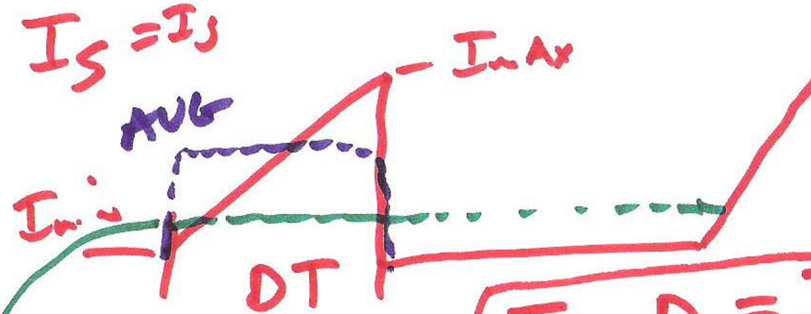
$$\frac{\Delta V_S \cdot T}{2L_{min}} = \frac{V_S \cdot D}{R(1-D)^2}$$

$$\boxed{L_{min} = \frac{R(1-D)^2}{2f}}$$

$$L_{min} = \frac{1\,(.67)^2}{200 \cdot 10^3} = 2.24\mu$$

5)

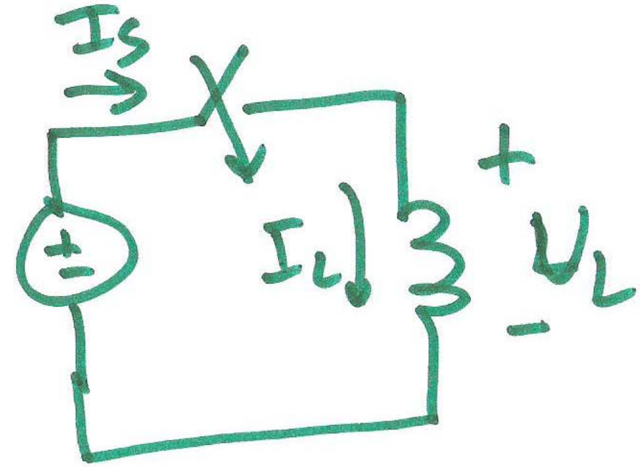


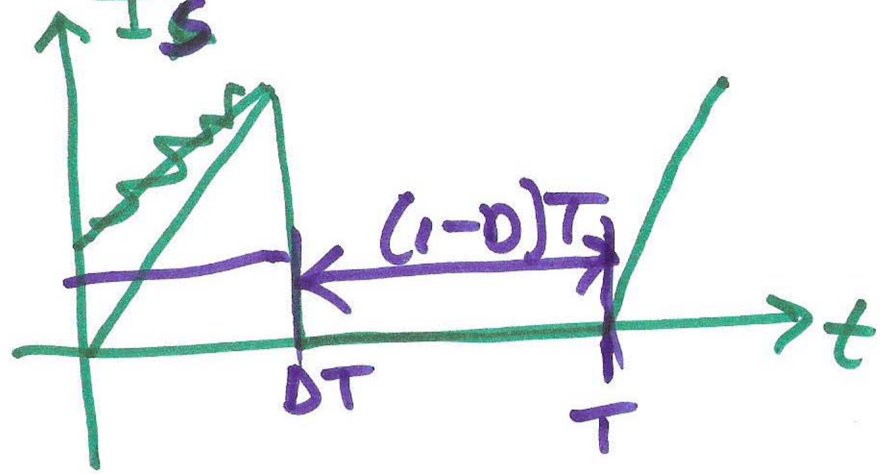


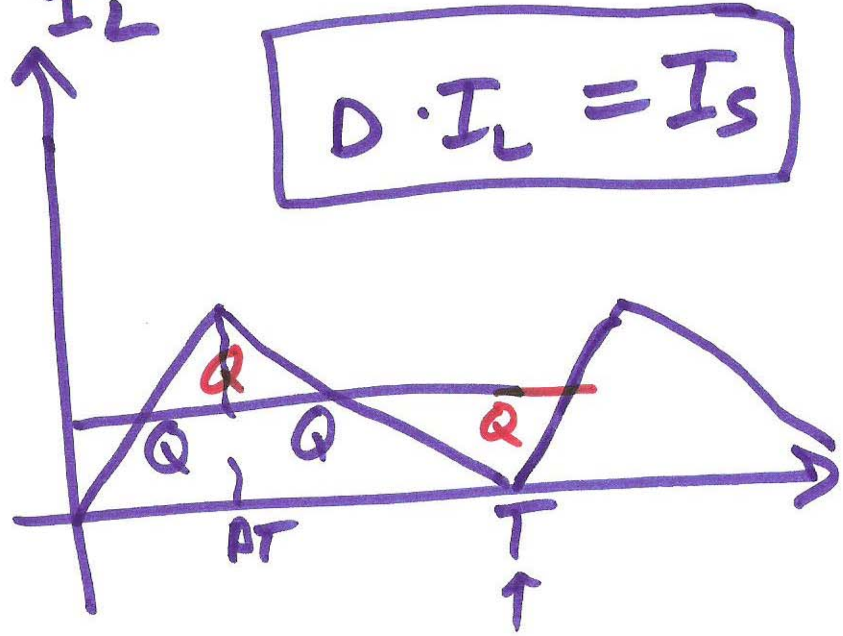
$$I_L \cdot D = I_S$$

$$I_S = \frac{\underbrace{\frac{I_{max} + I_{min}}{2}}_{AVG} \cdot D\not{T}}{\not{T}}$$

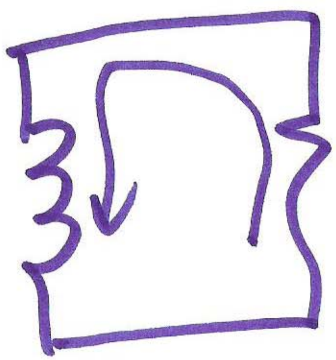
5)





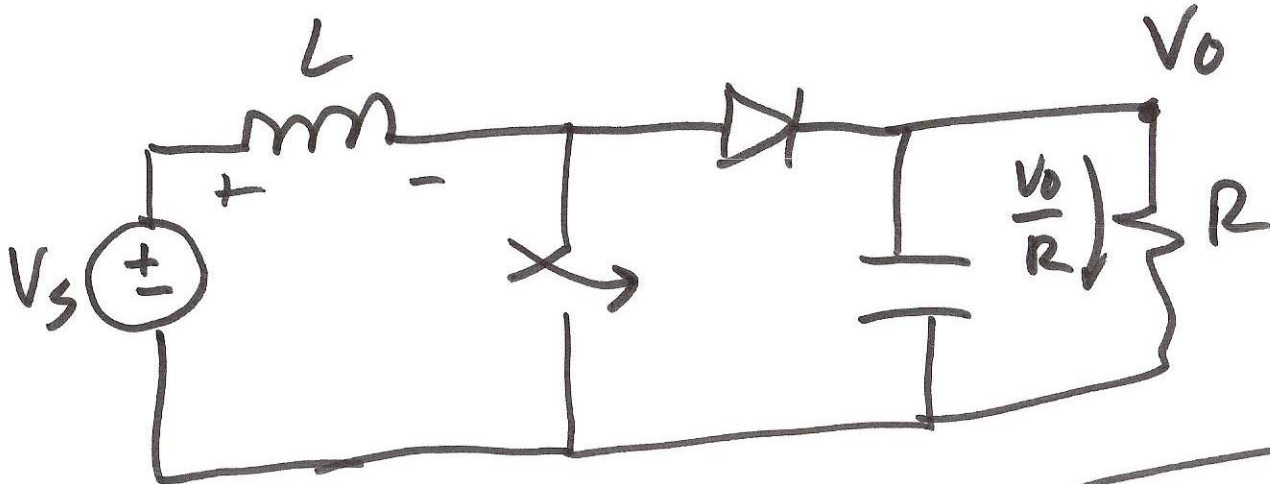


$$D \cdot I_L = I_S$$



6)

BoosT



$I_s = I_L$

Switch closed $\frac{V_s}{L} = \frac{\Delta i_L}{D \cdot T}$

$$\Delta i_L = \frac{V_s \cdot D \cdot T}{L}$$

Switch open $\frac{V_s - V_o}{L} = \frac{\Delta i_L}{(1-D)T}$

$$\Delta i_L = \frac{(V_s - V_o)T(1-D)}{L}$$

$D \cdot V_s = D V_s - D V_o$

$-V_s + V_o$

$\frac{V_s \cdot D \cdot T}{L} = \frac{(V_s - V_o)T(D-1)}{L}$

$$\frac{V_s}{1-D} = V_o$$

7)

$$\frac{V_o^2}{R} = V_s I_s \,, \qquad V_o = \frac{V_s}{1-D}$$

$$V_s = V_o(1-D)$$

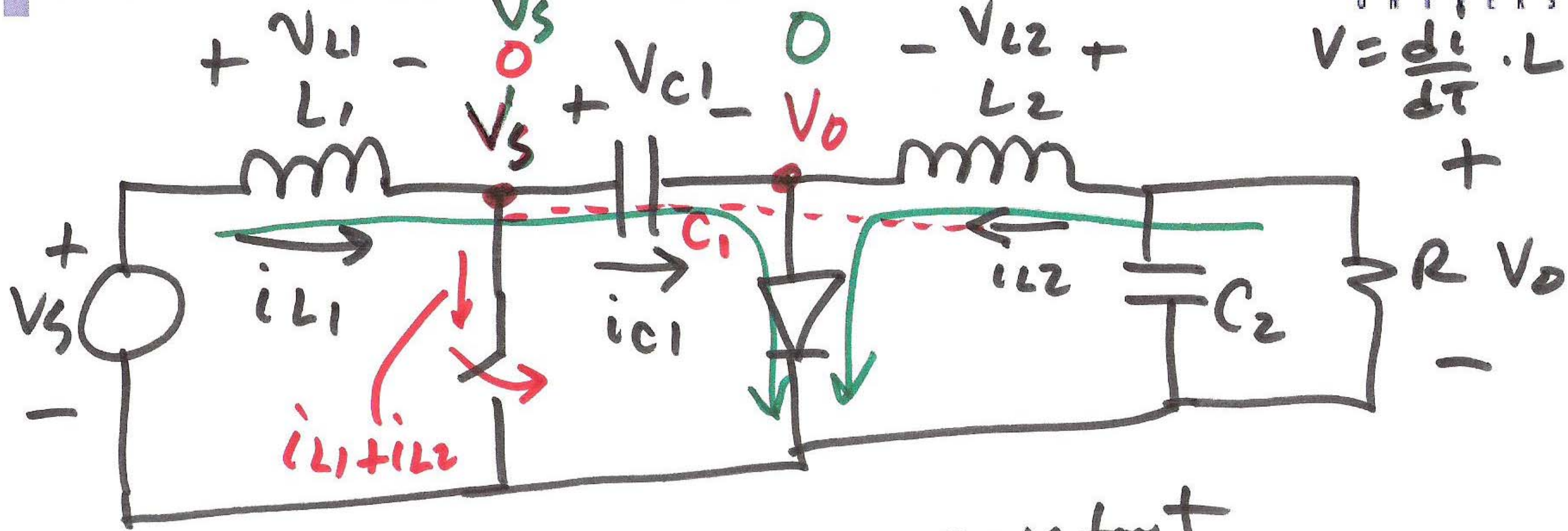
$$I_o = \frac{V_o^{\cancel{2}}}{R} = \cancel{V_o}(1-D)\cdot I_s$$

$$I_s = \frac{I_o}{1-D} \,, \qquad V_o = \frac{V_s}{1-D}$$

$$\boxed{V_o \cdot I_o = V_s \cdot I_s}$$

8)

Cu'K "Chook" converter



$V = \frac{di}{dT} \cdot L$

Currents are constant

$$-V_0 \cdot I_{L2} = V_S \cdot I_{L1}$$

$$V_{C1} = V_S - V_0$$

Switch is closed

$$i_{C1} = C\frac{dV}{dT} = -i_{L2} = C_1$$

Switch is open

$$i_{C1} = i_{L1}$$

9)

$$+ I_{L2} D T = I_{L1} (1-D) T$$

$$\boxed{\frac{I_{L1}}{I_{L2}} = \frac{D}{1-D}}$$

$$P_S = P_O$$

$$V_S \cdot I_{L1} = -V_O \cdot I_{L2}$$

$$\frac{I_{L1}}{I_{L2}} = \frac{-V_O}{V_S}$$

$$V_O = -V_S \cdot \left(\frac{D}{1-D} \right)$$