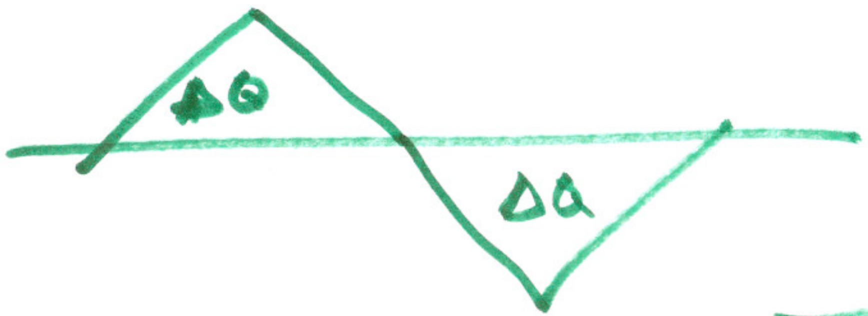
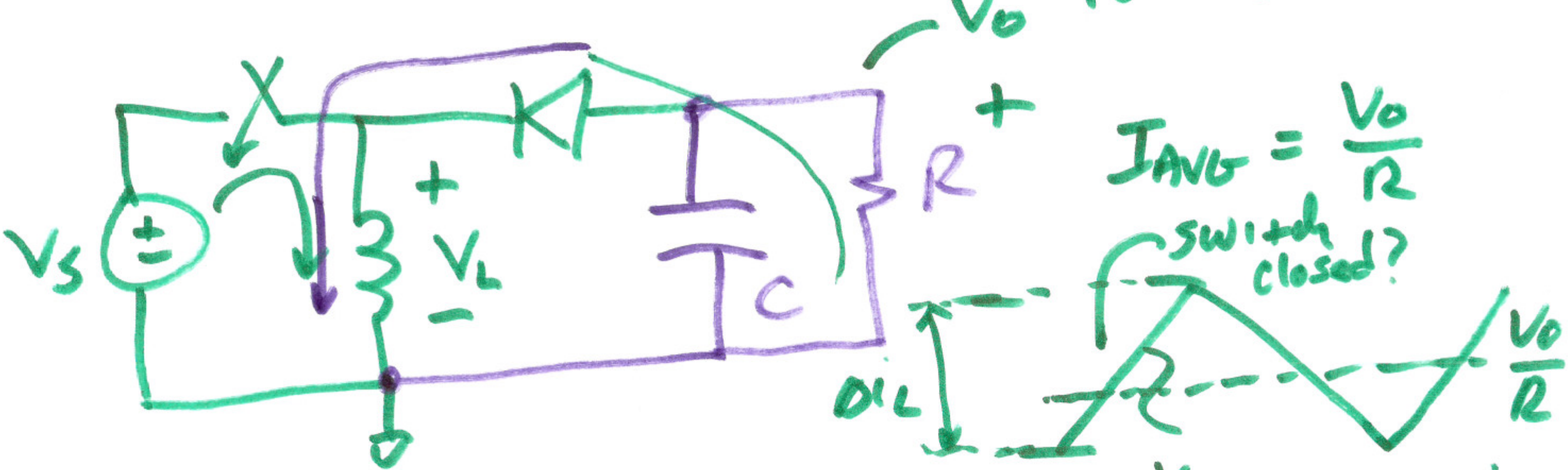
ECE 5/472 Power Electronics

BOISE STATE UNIVERSITY

Lecture 6, Sept. 6, 2011



Buck - Boost



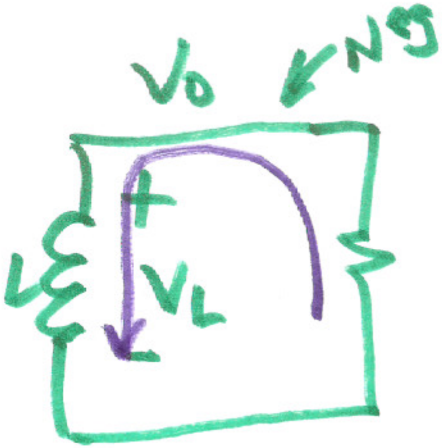
$I_{AVG} = \frac{V_o}{R}$

$\frac{V_S}{L} = \frac{V_L}{L} = \frac{di_L}{dT}$

1)

$$\frac{\Delta i_L}{DT} = \frac{V_s}{L}$$

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



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

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

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

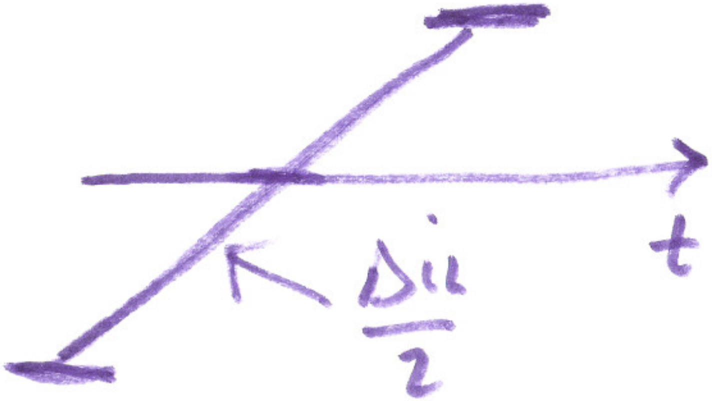
$$\frac{V_o}{V_s} = \frac{D}{D-1}$$

$V_s = 10V$

$D = 0.5$

$V_o = -10V$

2)



$$\frac{V_o}{R} = \left(\frac{D}{D-1}\right)\frac{V_s}{R}$$

$$\frac{V_s}{R}\left(\frac{D}{1-D}\right) + \frac{\Delta i_L}{2} = \frac{V_s}{2L_{min}} \cdot DT - \frac{V_s}{R}\left(\frac{D}{D-1}\right) = 0$$

$$\frac{1}{2fL_{min}} = \frac{DT}{2L_{min}} = \frac{1}{R}\,\frac{D}{D-1}$$

$$\boxed{L_{min} = \frac{-R(D-1)^2}{2f}} = \frac{5(.6)^2}{2 \cdot 10^5}$$

$$\frac{5 \cdot .36}{2 \cdot 10^5}$$

9μH ↑

$$\frac{3}{2} \cdot 10^{-5}$$

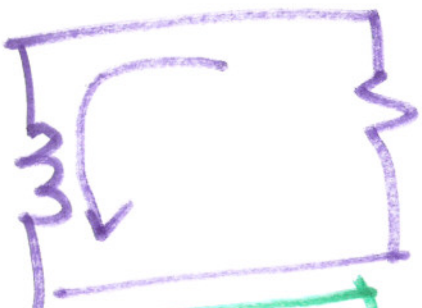
15 μH

3)

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

$$\frac{V_s \cdot D}{R(D-1)^2} = \frac{V_s}{L} \cdot \frac{DT}{2}$$

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



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

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

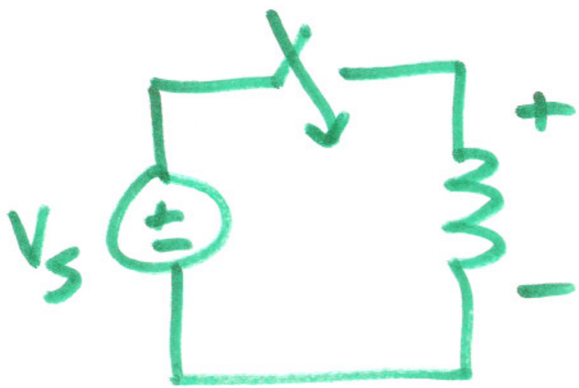
$$\frac{V_o(1-D)T}{2L_{min}} = \frac{D}{D-1}\frac{V_s}{R}$$

$$\frac{\Delta i_L}{2} = \frac{V_s \cdot DT}{2L}$$

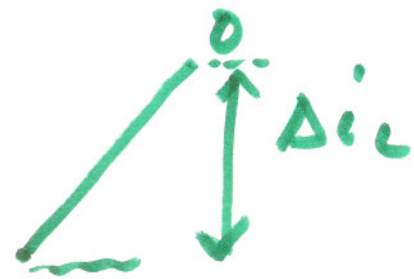
$$I_L = \frac{V_o}{R}$$

$$I_s \cdot V_s = I_o V_o$$

5)



$$\frac{\Delta i_L}{2} = DT \cdot \frac{V_s}{L\,2}$$



$$P_s = \frac{V_s^2 (DT)^2}{2 L_{min}}$$

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

$$P_s = P_L$$

$$P_s = \frac{V_o^2 \cdot (1-D)^2}{2 L_{min}\, D f}$$

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

$$P_L = \frac{V_o^2}{R}$$

6)

$$\frac{V_o}{R} \cdot DT = \Delta Q$$

$$CV = Q$$

$$\Delta V_o = \frac{\Delta Q}{C}$$

Amp · sec

$$\frac{\text{Cols}}{s} \cdot \text{sec.}$$

$$\Delta V_o = \frac{V_o}{CR} \cdot DT$$

$$\boxed{\frac{\Delta V_o}{V_o} = \frac{DT}{RC}}$$

$$\frac{V_o}{\Delta V_o} = \frac{CR}{DT}$$

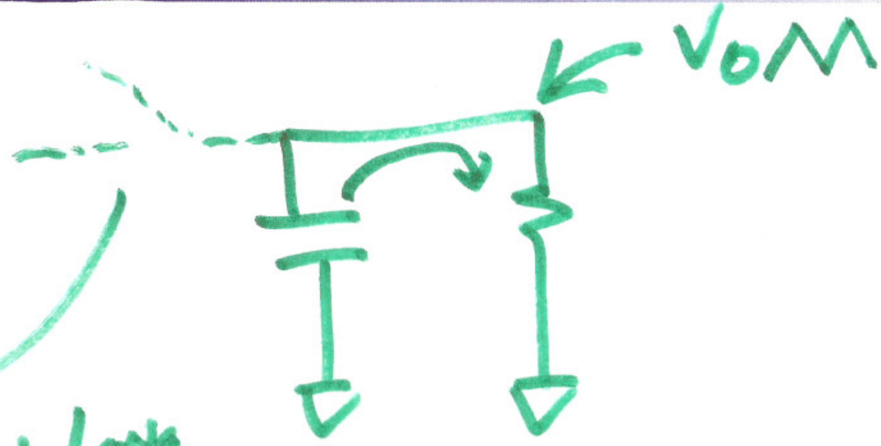
$$= \frac{80\mu \cdot 5}{.4 \cdot 10\mu}$$

$$= \frac{400}{4} = 100$$

1%

.01

7)



How Long open

DT

$$\frac{V_o}{R} \cdot DT = \Delta Q$$

$$CV = Q$$

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

$$e^x \simeq 1 + \frac{x}{1} + \frac{x^2}{2!} + \ldots$$

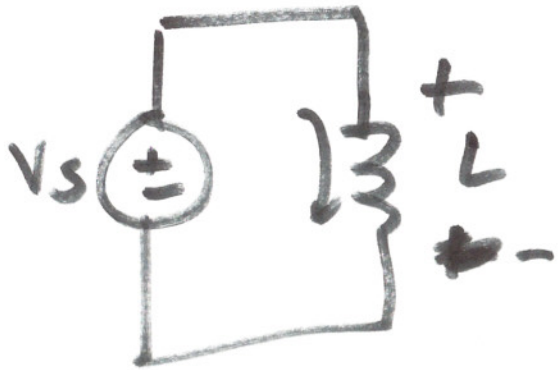
$$\Delta V = \frac{V_o DT}{RC}$$

$$1\% = .01 = \frac{\Delta V}{V} = \frac{DT}{Rc}$$

if $V = 16\,V$

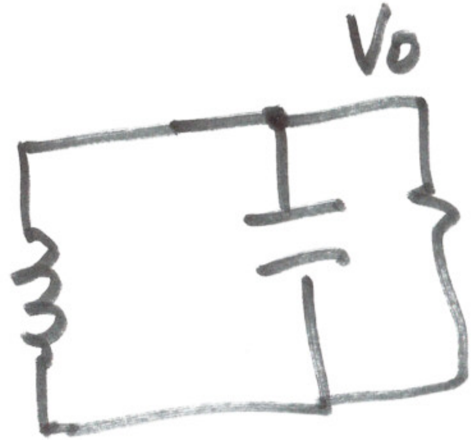
$$\Delta V = \underline{\underline{160\,mV}}$$

L_{MIN}



$$\frac{\Delta i_L}{2} = \frac{V_s}{2L} \cdot DT$$

$$P_s = \frac{V_s^2 \cdot DT}{2L}$$



$$P_L = \frac{V_o^2}{2L} \cdot (1-D)T$$

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

$$-(1-D)$$

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

$$\frac{(1-D)^2 \cdot V_o^2 \cdot DT}{D^2 \cdot 2L}$$

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

$$I_s = D I_L$$

$$I_o = \frac{V_o}{R} \text{ (Average current)}$$

10)