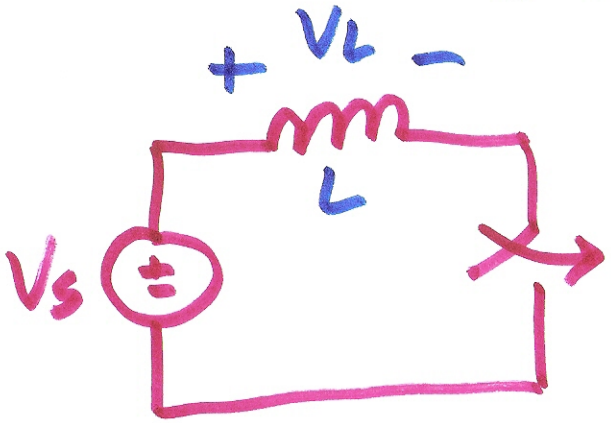
ECE 5/472 Power Electronics

BOISE STATE UNIVERSITY

Lecture 12

Sept. 22 2010

Boost converter switch closed



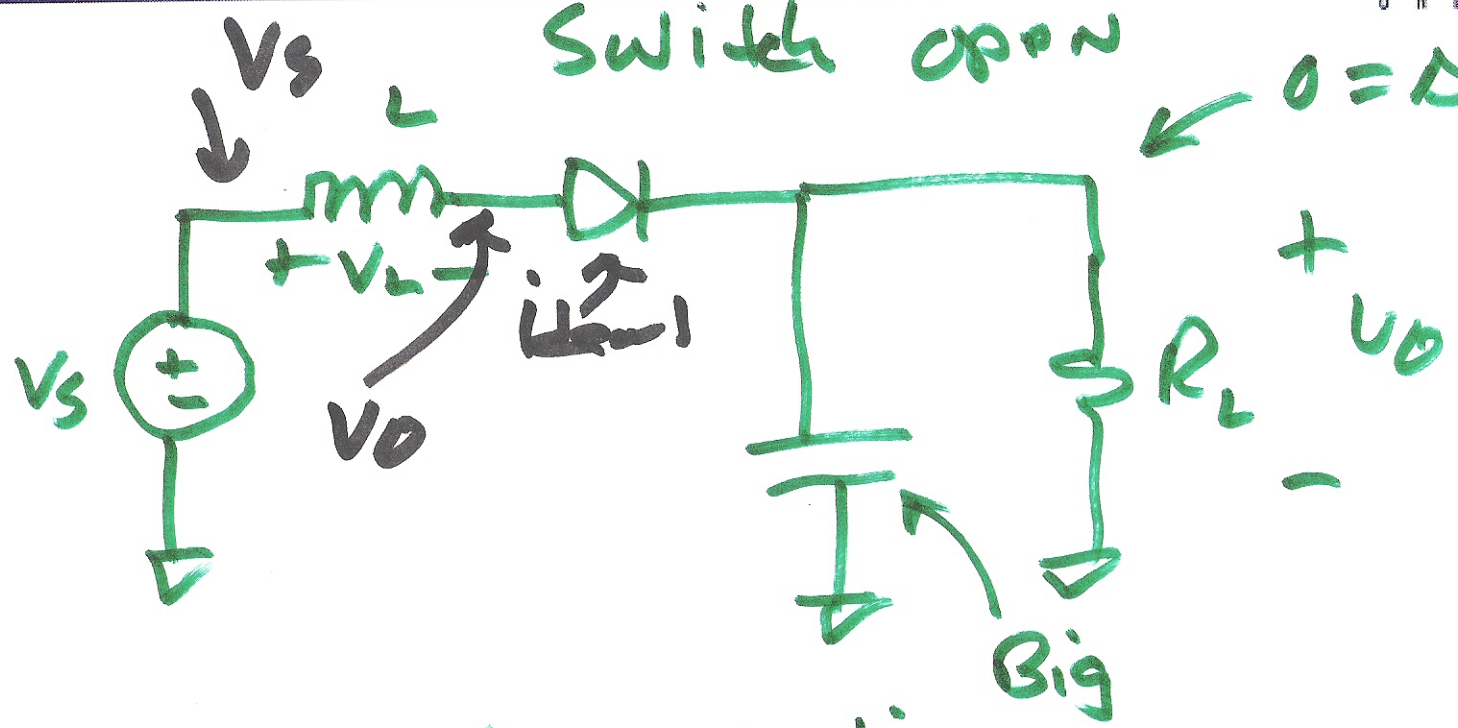
$$V_s = V_L = L\frac{di_L}{dt}$$

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

$t_{on} =$

$$(\Delta i_L)_{closed} = \frac{V_s \cdot D \cdot T}{L}$$

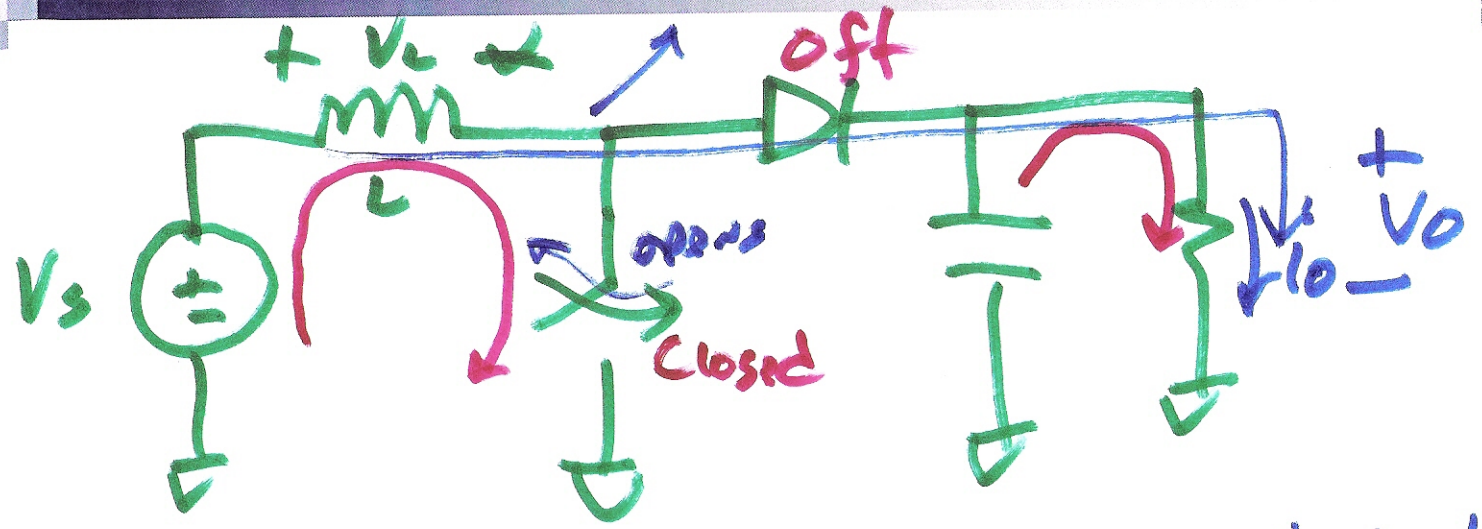
Boost



$$\frac{V_s - V_o}{L} = L \cdot \frac{di_L}{dt}$$

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

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



$V_s \cdot i_L$ = power supplied by V_s

$V_o \cdot i_o$ = power delivered to load

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

100%

$$V_s \cdot i_L = V_o \cdot i_o$$

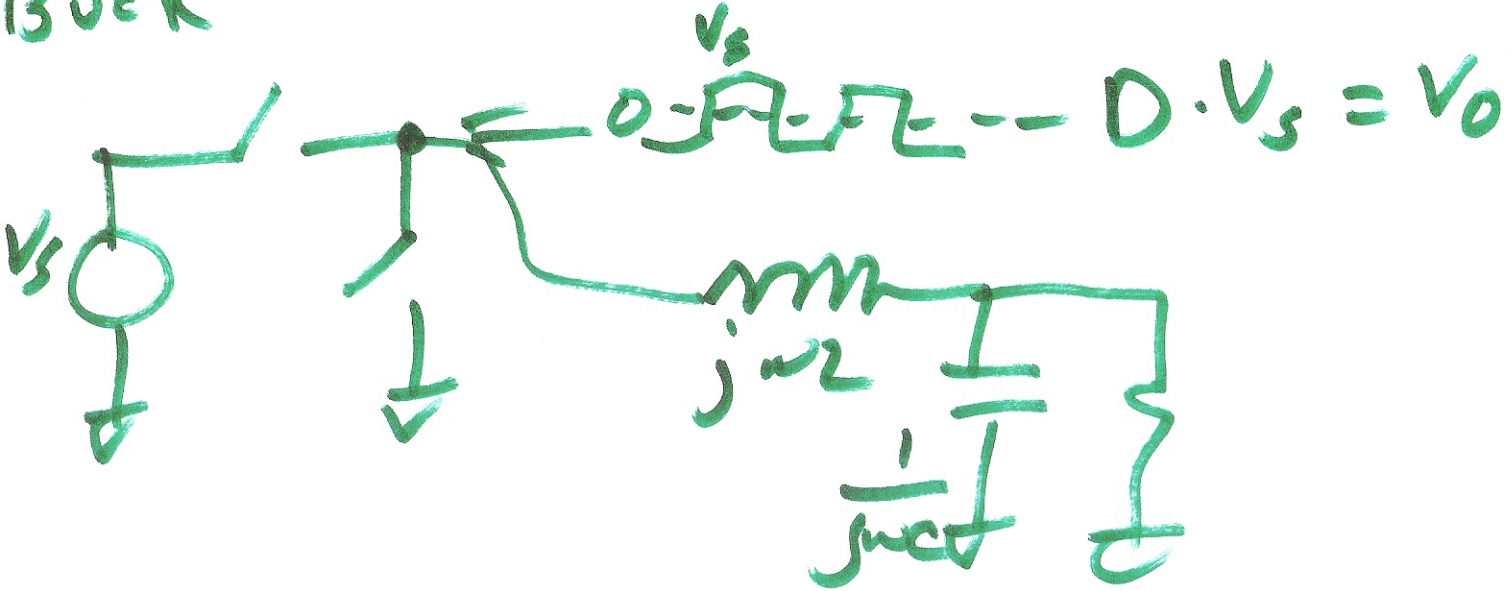
$$v_L = L \frac{di_L}{dt}$$

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

$$\frac{V_s \cdot DT}{L} + \frac{(V_s - V_o)(1-D)T}{L} = 0$$

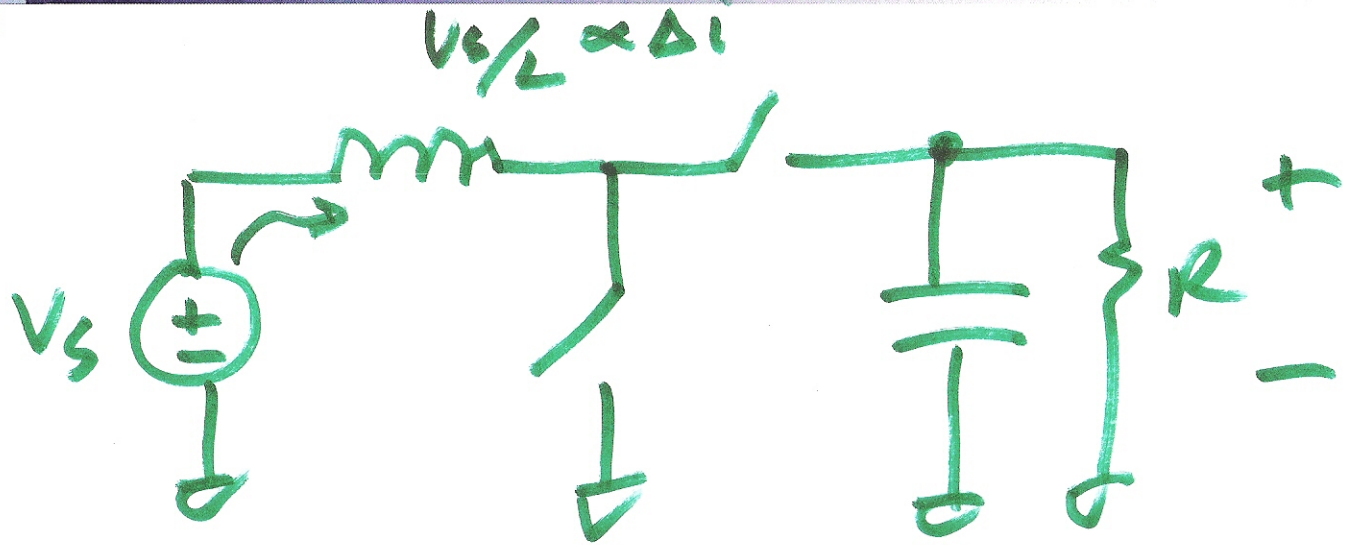
$$\boxed{V_o = \frac{V_s}{1-D}}$$

Buck



4)

Boost+



$$V_o = \frac{V_s}{1-D} \quad , \quad \frac{V_o}{V_s} = \frac{i_s}{i_o}$$

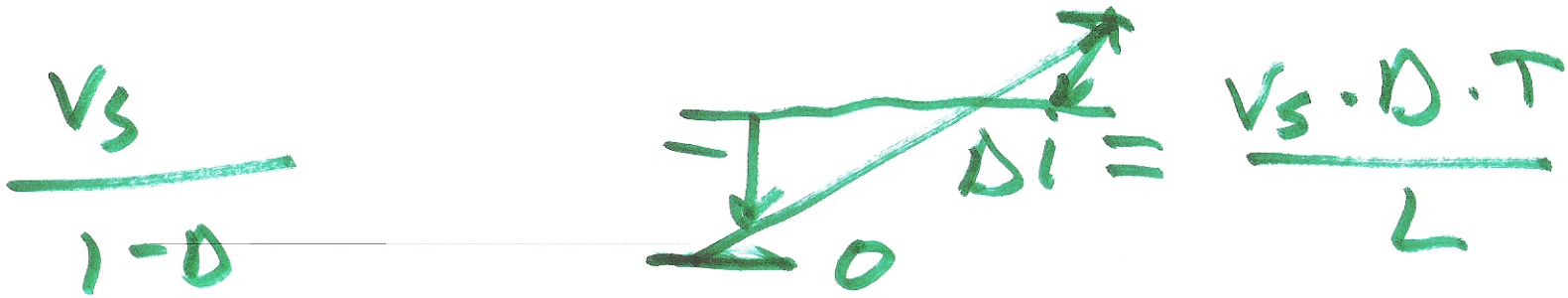
$$i_o = i_s(1-D) \qquad \frac{i_s}{i_o} = \frac{1}{1-D}$$

5)

Boost

$$I_{min} = 0 = \frac{V_s}{(1-D)^2 \cdot R} = \frac{V_o}{(1-D)R} - \frac{V_s \cdot DT}{2L}$$

$\frac{V_s \cdot DT}{2L}$



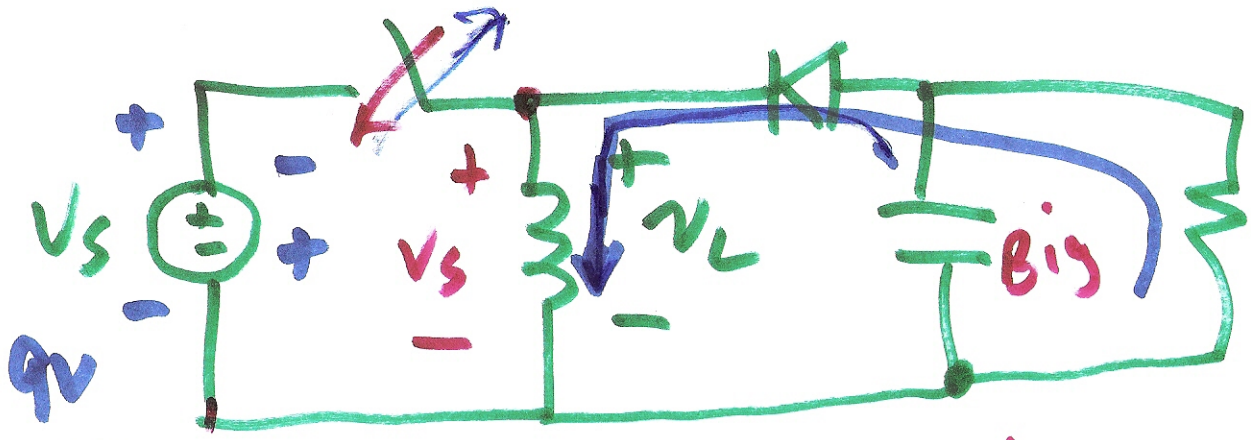
$$I_{min} = \frac{V_s \cdot D}{2L \cdot f}$$

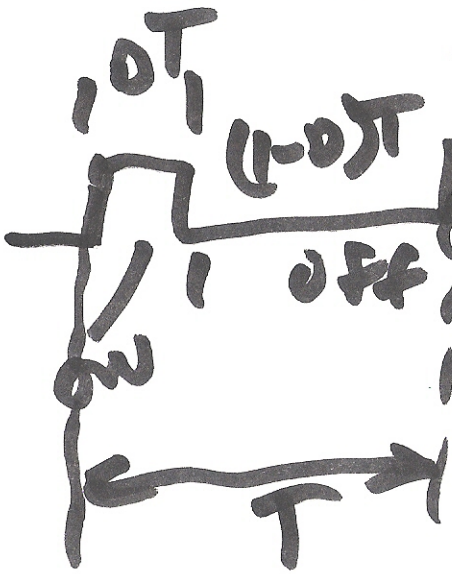
6.32

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

6)

Buck - Boost Converter





$$V_s = V_L = L \cdot \frac{di_L}{dt}$$ switch closed

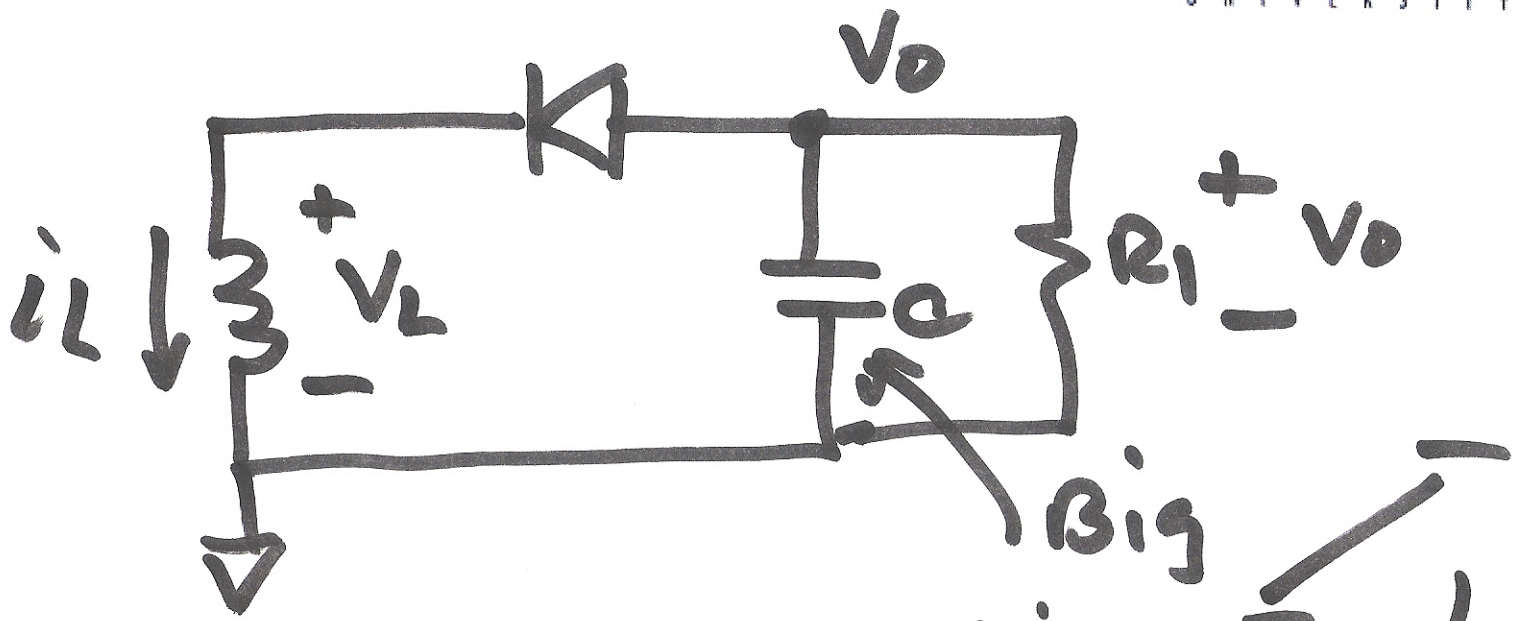
$$\frac{V_s}{L} = \frac{\Delta i_{L,ON}}{D \cdot T}$$

$$\Delta i_{L,\text{closed}} = \frac{D \cdot T \cdot V_s}{L}$$

switch close
Vo is neg.

(6-45)

Switch open



$$V_L = V_o = L \cdot \frac{di_{L,off}}{dt}$$

$$\frac{V_o}{L} = \frac{\Delta i_{L,off}}{(1-D)T}$$

(6-46)

$$\Delta i_{L,off} = \frac{V_o (1-D) \cdot T}{L}$$

8)

$$\frac{V_s \cdot D \cdot T}{L} + \frac{V_o (1-D) T}{L} = 0$$

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

(6-47)

Boost output Ripple

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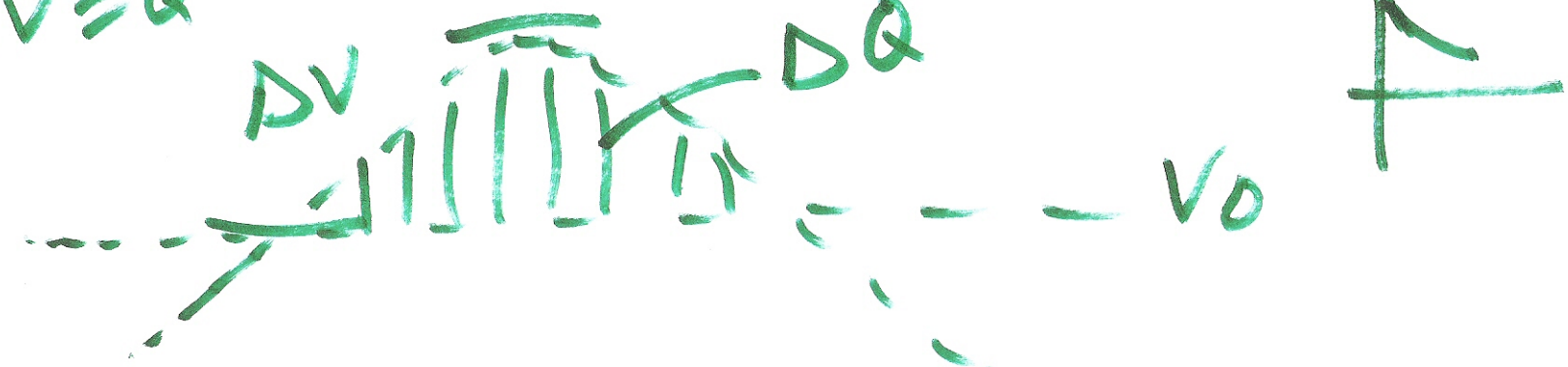
$CV = Q$



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

$$\Delta I_o \cdot (1-D)T = \Delta Q$$

$$i_L = i_C + i_o$$

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

1F
10^{-15}