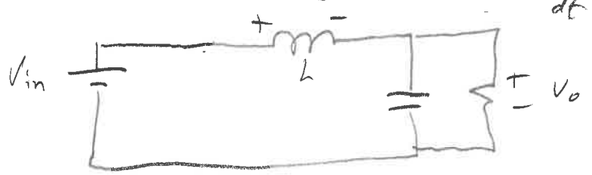
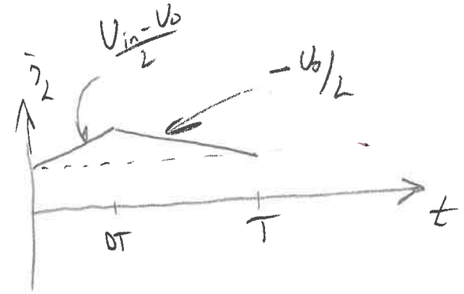
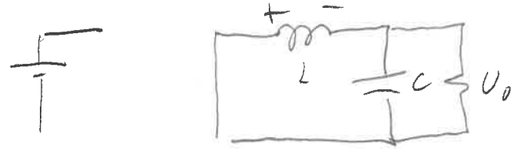
# Buck


Switch closed $\quad V_L = V_{in} - V_o = L \frac{di_L}{dt}$



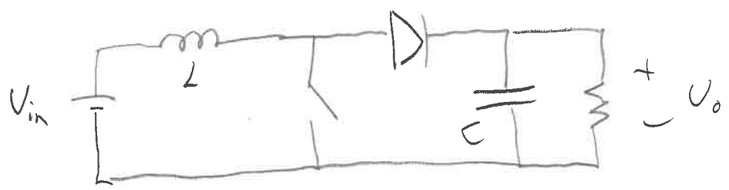

Switch open $\quad v_L = -v_o = L \frac{di_L}{dt}$




$$\Delta i_L = DT\left(\frac{V_{in}-V_o}{L}\right) + T(1-D)\left(-\frac{V_o}{L}\right) = 0$$

$$\Rightarrow \quad V_o = D V_{in}$$

# Boost

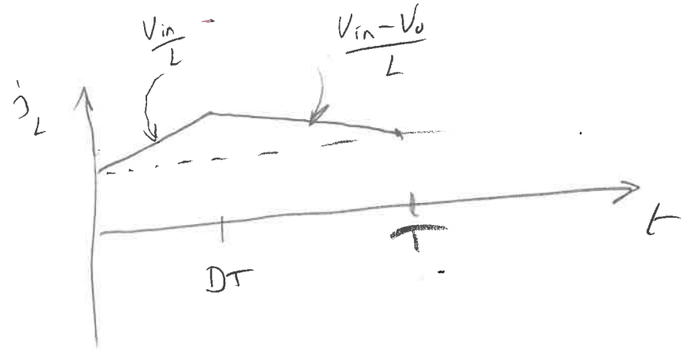



Switch closed

$V_L = V_{in} = L\, di/dt$


Switch open

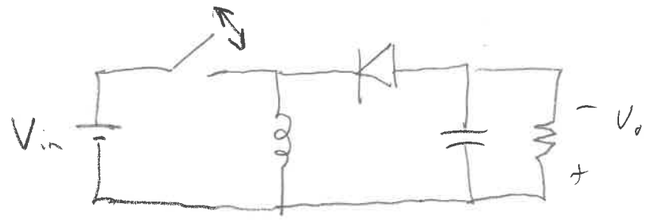
$V_L = V_{in} - V_o = L \frac{di_L}{dt}$

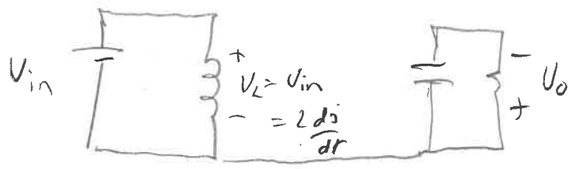

$$\Delta i = DT\left(\frac{V_{in}}{L}\right) + T(1-D)\left(\frac{V_{in}-V_o}{L}\right) = 0$$

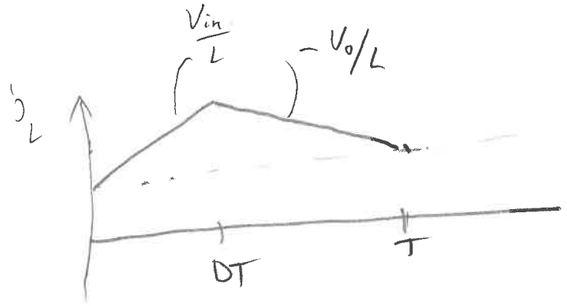
$$\Rightarrow \quad V_o = \frac{V_{in}}{1-D}$$

# Buck - Boost




Switch closed



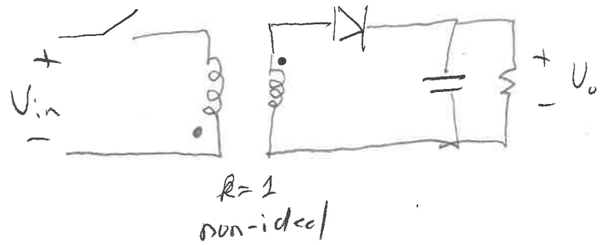

Switch Open

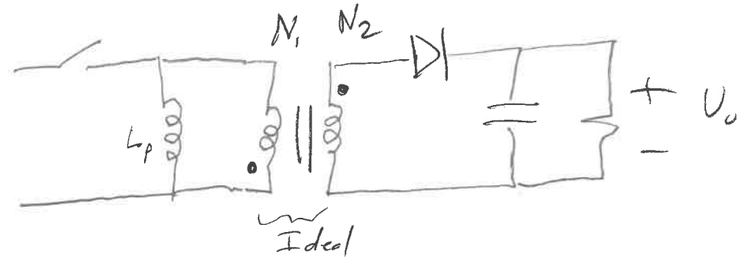
$V_L = -V_o = L\frac{di_L}{dt}$


$$\Delta i = DT\left(\frac{V_{in}}{L}\right) + T(1-D)\left(-\frac{V_o}{L}\right) = 0$$

$$V_o = \frac{D}{1-D} V_{in}$$

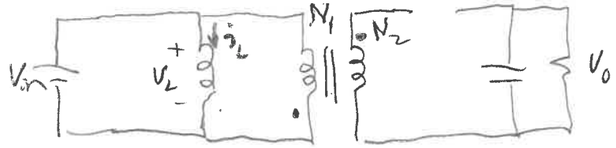
# Fly Back

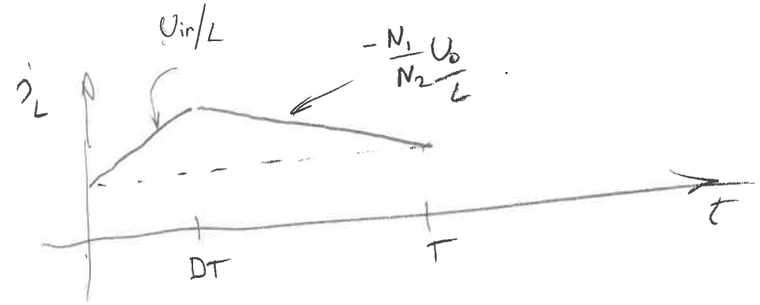



Switch - Closed

$V_L = V_{in} = L\, di_L/dt$




$$\Delta i_L = DT\left(\frac{V_{in}}{L}\right) + T(1-D)\left(-\frac{N_1}{N_2}\frac{V_o}{L}\right) = 0$$

Switch open


$$V_L = -\frac{N_1}{N_2}V_o = L\frac{di_L}{dt}$$

$$V_o = \frac{N_2}{N_1} \times \frac{D}{1-D}\, V_{in}$$