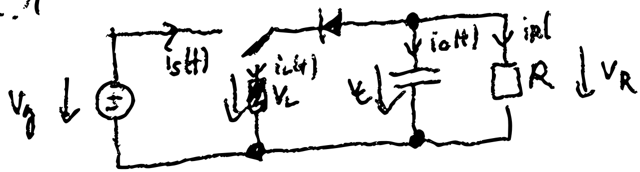
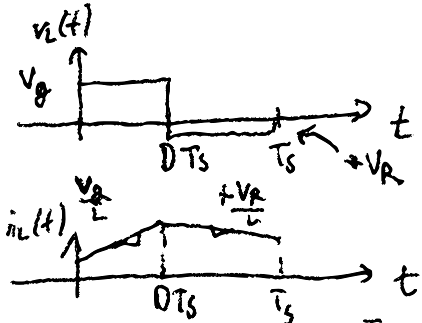
Problems

2.1

a)





$$\Leftrightarrow v_L(t) = L\frac{di_L(t)}{dt} \Leftrightarrow \int_0^{T_s} \frac{v_L(t)}{L}\,dt = \int_{i_L(0)}^{i_L(T_s)} di_L = i_L(T_s) - i_L(0) = 0$$

$$\Leftrightarrow \int_0^{DT_s} \frac{v_L(t)}{L}\,dt + \int_{DT_s}^{T_s} \frac{v_L(t)}{L}\,dt = D\cancel{T_s}\cdot\frac{V_g}{L} + \frac{V_R}{L}\cancel{T_s} - \frac{V_R\cdot D\cancel{T_s}}{L} = 0$$

$V_R = V_{out}$

$$\Leftrightarrow D\frac{V_g}{L} + \frac{V_R}{L} - \frac{V_R\cdot D}{L} = 0 \Leftrightarrow DV_g + V_{out} - V_{out}\cdot D = 0$$

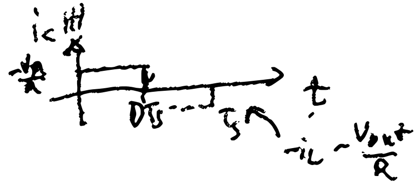
$$\Leftrightarrow D(V_g - V_{out}) + V_{out} = 0 \Leftrightarrow \frac{V_{out}}{(V_g - V_{out})} = -D$$

$$\rightsquigarrow D = \frac{V_{out}}{(V_{out} - V_g)}$$

$\Leftrightarrow i_c(t) = C\frac{dv_c(t)}{dt} \Leftrightarrow \frac{1}{C}\int_0^{T_s} i_c\,dt = \int_{v_c(0)}^{v_c(T_s)} dv_c = 0$

$0 \le t < DT_s$

$i_R = -i_c \;\wedge\; -\frac{V_R}{R} = i_c$



$DT_s \le t < T_s$

$i_L + i_C + i_{R} = 0 \Leftrightarrow i_C = -i_L - i_R$

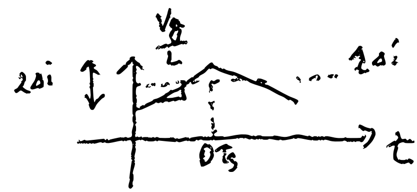
$i_c = -i_L - \frac{V_{out}}{R}$

$\Leftrightarrow \int_0^{DT_s} i_c\,dt + \int_{DT_s}^{T_s} i_c\,dt = -\frac{V_{out}}{R}D\cancel{T_s} + \cancel{T_s}\left(-i_L - \frac{V_{out}}{R}\right) - D\cancel{T_s}\left(-i_L - \frac{V_{out}}{R}\right)$

$\Leftrightarrow -\cancel{\frac{V_{out}}{R}D} - i_L - \frac{V_{out}}{R} + Di_L + \cancel{D\frac{V_{out}}{R}} = 0$

$-i_L(1-D) - \frac{V_{out}}{R} = 0$

$i_L = -\frac{V_{out}}{R(1-D)}$



$A = 2\Delta i_L$

2.2 c)

Given: $V_g = 30V$, $V = -20V$, $R = 4\Omega$

$\Delta v_c = 0.1$, $\Delta i_L = 0.5 \cdot I = 0.5 i_L$

$f_s = 40kHz$,

i) $D = \frac{-20V}{(-20V - 30V)} = \underline{\underline{0.4}}$, $i_L = -\frac{(-20V)}{4\Omega(1-0.4)} = \underline{\underline{8.33A}}$

$v_L = L\frac{di_L}{dt} = L\frac{\Delta i_L}{\Delta t}$ $\quad L = \frac{v_L \cdot \Delta t}{\Delta i_L} = \frac{V_g \cdot DT_s}{0.1 \cdot 8.33A} = \underline{\underline{360.144\mu H}}$

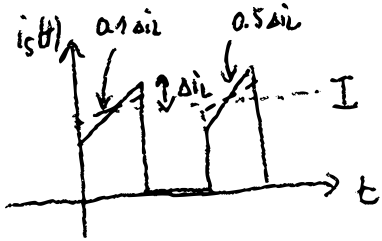
ii) $i_L = \frac{20V}{4\Omega(1-D)} = \underline{\underline{8.33A}}$

iii)

$$i_C = C\frac{dv_C}{dt} = -\frac{V_{out}}{R} = C\frac{\Delta v_C}{DT_S} \Leftrightarrow -\frac{V_{out}}{R}\cdot DT_S\cdot\frac{1}{\Delta v_C} = C$$

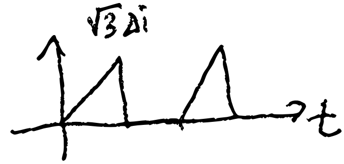
$$\underline{\underline{C = 25\mu F}}$$

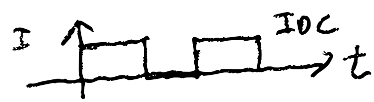
d.)



$$I_{RMS} = \sqrt{D}\left(I - \frac{di}{2} + \frac{\sqrt{3}\Delta i_L}{3}\right)$$

$$v_L = L\frac{\Delta i_L}{\Delta t} \Leftrightarrow \Delta i_L = \frac{V_L\cdot DT_S}{L}$$





10% Δi_{L1}

$\rightarrow i_{s,peak_1} = I + \Delta i_{L1}$
$= \underline{\underline{9.163A}}$

50% Δi_{L2}

$\rightarrow i_{s,peak_2} = \underline{\underline{12.5A}}$

$$v_L = L\frac{\Delta i_L}{\Delta t} \qquad L = \frac{\Delta t\cdot V_L}{\Delta i_L}$$

⇝ smaller Inductances

Disadvantage: Higher Losses!

Higher Peak currents in Diodes and Switches