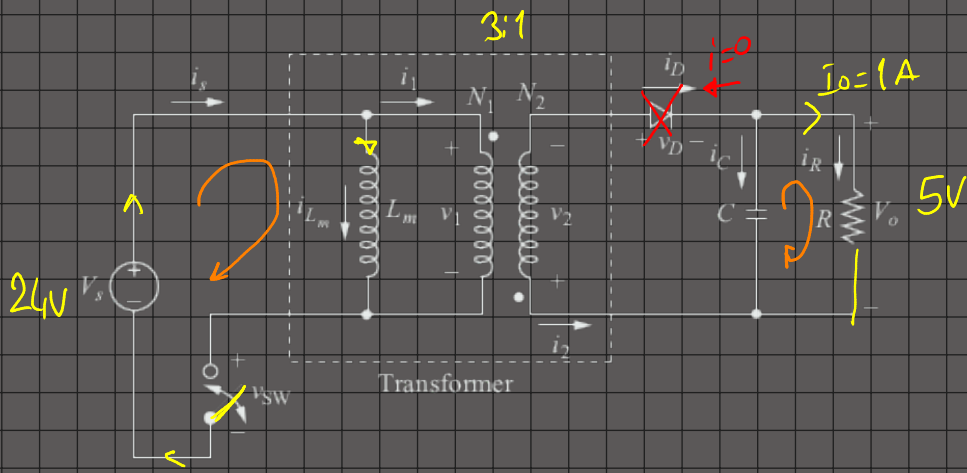
Hart ex. 7.1

Flyback Converter

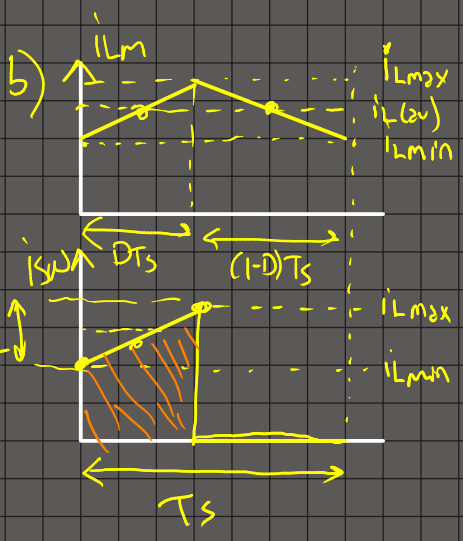
A flyback converter of Fig. 7-2 has the following circuit parameters:

$V_s = 24$ V
$N_1/N_2 = 3.0$
$L_m = 500$ μH
$R = 5$ Ω
$C = 200$ μF
$f = 40$ kHz
$V_o = 5$ V

Determine (*a*) the required duty ratio D; (*b*) the average, maximum, and minimum values for the current in L_m; and (*c*) the output voltage ripple. Assume that all components are ideal.



a) $\frac{V_o}{V_s} = \frac{D}{(1-D)} \cdot \frac{N_2}{N_1} \Rightarrow \frac{5}{24} = \frac{D}{(1-D)} \frac{1}{3} \Rightarrow D = 0{,}385$



$i_{s(av)} = ?$

$P_{out} = P_{in}$

$5W = 24V \cdot i_{s(av)}$

$\hookrightarrow i_{s(av)} = 5/24$ A

$i_{s(av)} = \frac{i_{Lmin} + i_{Lmax}}{2} \cdot \frac{DT_s}{T_s} = \frac{5}{24}$ A

$i_{L(av)} = \frac{i_{Lmin} + i_{Lmax}}{2} = \frac{5}{24} \cdot \frac{1}{0{,}385} = 540$ mA

$\Delta i_L = \frac{V_s \, DT_s}{L_m} = \frac{24 \cdot 0{,}385}{500\mu H \; 40kH_z} = 460$ mA

$L = \frac{N^2}{R}$

$i_{Lmin} = i_{L(av)} - \frac{\Delta i_L}{2} = 540 - \frac{460}{2} = 310$ mA

$i_{L(max)} = 540 + \frac{460}{2} = 770$ mA

$i_{Lmin} > 0 \Rightarrow$ CCM

$$i_{L(max)} \propto \hat{\phi}_{core} \propto \hat{B}_{core}$$

C) $\Delta V_o = ?$ ⇒ Capacitor supplies the load during on period.

$$\Delta V_o = \frac{i_o \cdot DT_s}{C} = \frac{1A \cdot 0{,}38\,s}{200\mu\ 40kHz} \simeq 0{,}05V$$

$$\frac{\Delta V_o}{V_o} = \frac{0{,}05}{5} \Rightarrow \%1 \text{ (acceptable)}$$