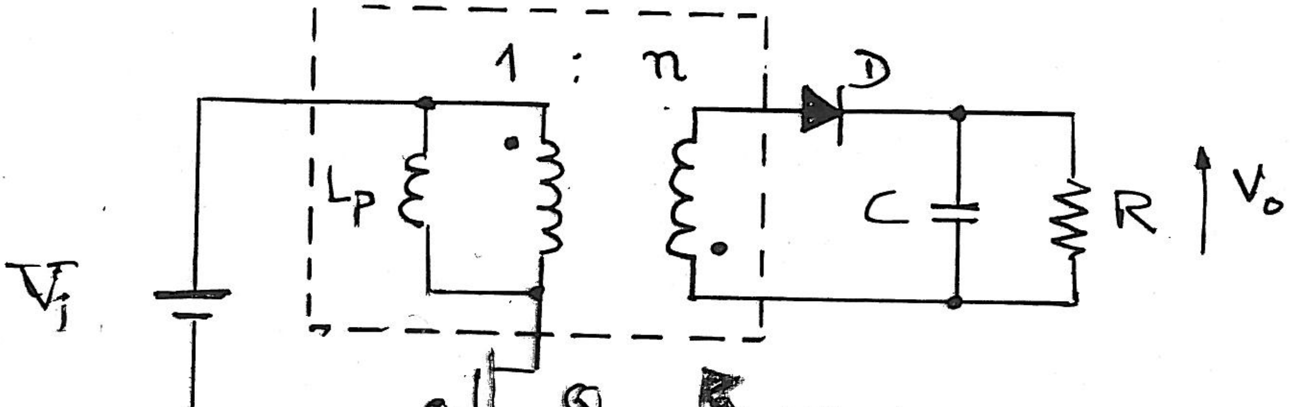
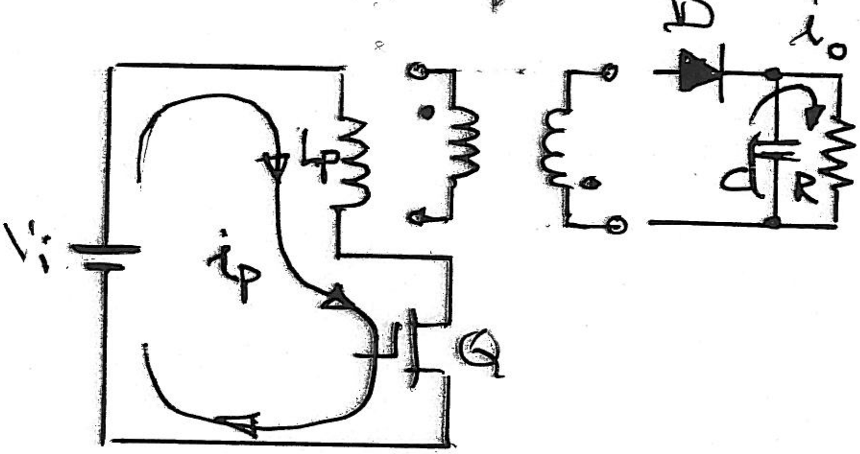
FLYBACK DC|DC CONVERTER

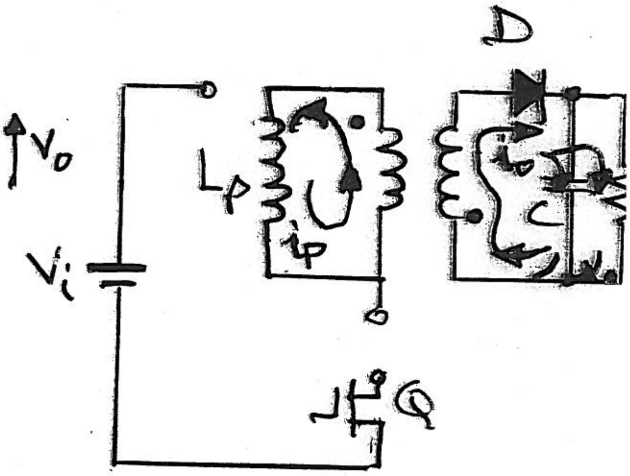


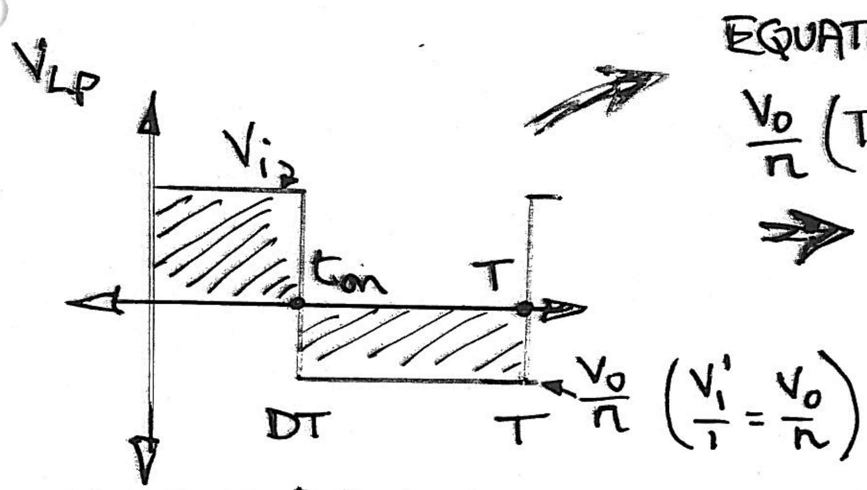
TRANSFORMER:-
NEGLECT L_{lk} HERE
L_p = MAGNETISING INDUCTANCE

Q ON



Q OFF





VOLTAGE ACROSS Lp

EQUATING AREAS

$$\frac{V_o}{n}(T - t_{on}) = V_i t_{on}$$

$$\Rightarrow \quad \frac{V_o}{V_i} = n\left(\frac{D}{1-D}\right)$$

* AS BEFORE

$$I_{p\,max} - I_{p\,min} = \frac{V_1 DT}{L_p}$$

* INPUT POWER = OUTPUT POWER

$$P_o = V_o^2/R = P_i = V_i I_{i(avg)} = V_i \left(\frac{I_{p\,max} + I_{p\,min}}{2} \right) D$$

* SOLVE FOR $I_{p\,max}$ AND $I_{p\,min}$
* FOR CONTINUOUS CONDUCTION

$$I_{p\,min} \geq 0$$

$$\Rightarrow \qquad L_p \geq \frac{(1-D)^2 T}{2} \left(\frac{R}{n^2} \right)$$

* SAME AS NON-ISOLATED BUCK-BOOST WITH REFLECTED LOAD RESISTANCE (R/n^2) AS EXPECTED

* BE CAREFUL WITH THE MAXIMUM SWITCH BLOCKING VOLTAGE DURING THE OFF-TIME

$$V_Q = V_i + \frac{V_o}{n} = V_i + \frac{1}{n}\left(\frac{nD}{1-D} \right) V_i$$

$$= V_i \left[1 + \frac{D}{1-D} \right]$$

$$V_Q = \frac{V_i}{1-D}$$

E.G. $V_Q = 2V_i$ FOR $D = 1/2$!

FLYBACK CONVERTER DESIGN

EXERCISE P. 15.

CONTINUOUS MODE FLYBACK CONVERTER

$$P_o = 150\,W \ @ \ 5.0\,V\,dc$$

$$V_{IN} = 300\,V$$

$$f = 100\,kHz$$

$$\frac{N_1}{N_2} = 60$$

I_o = AVERAGE O/P CURRENT $= P_o / V_o = \frac{150}{5} = 30A$

RATED LOAD RESISTANCE $= \frac{V_o}{I_o} = \frac{5}{30} = 0.167\Omega$

FOR CONTINUOUS MODE OPERATION

$$\frac{V_o}{V_{IN}} = \frac{nD}{1-D}, \quad n = \frac{N_2}{N_1}$$

$$\Rightarrow \quad D = \frac{1}{\left[1 + \frac{nV_{IN}}{V_o}\right]}$$

$$\Rightarrow \quad D = \frac{1}{\left[1 + \frac{300}{60 \times 5}\right]} = \frac{1}{2} \quad (*)$$

THE REFLECTED CORE VOLTAGE DURING THE OFF-TIME IS V_o/n SO THAT THE SWITCH VOLTAGE IS $V_{SW} = \left[V_{IN} + V_o/n\right]$

HENCE

$$V_{SW} = \frac{V_{IN}}{1-D}$$

SO THAT

$$V_{SW} = \frac{300}{1-\frac{1}{2}} = 600\text{V} \quad (**)$$

WHICH IS THE MINIMUM SWITCH BLOCKING VOLTAGE

THE MAGNETISING INDUCTANCE FOR CONTINUOUS CURRENT OPERATION IS

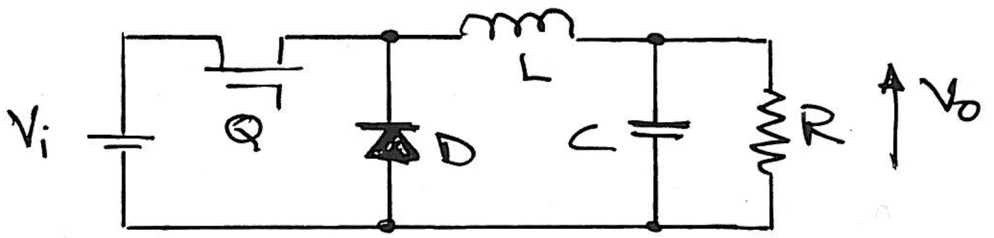
$$L_m \geq \left(\frac{R}{n^2}\right)(1-D)^2 \frac{T_s}{2}$$

HENCE

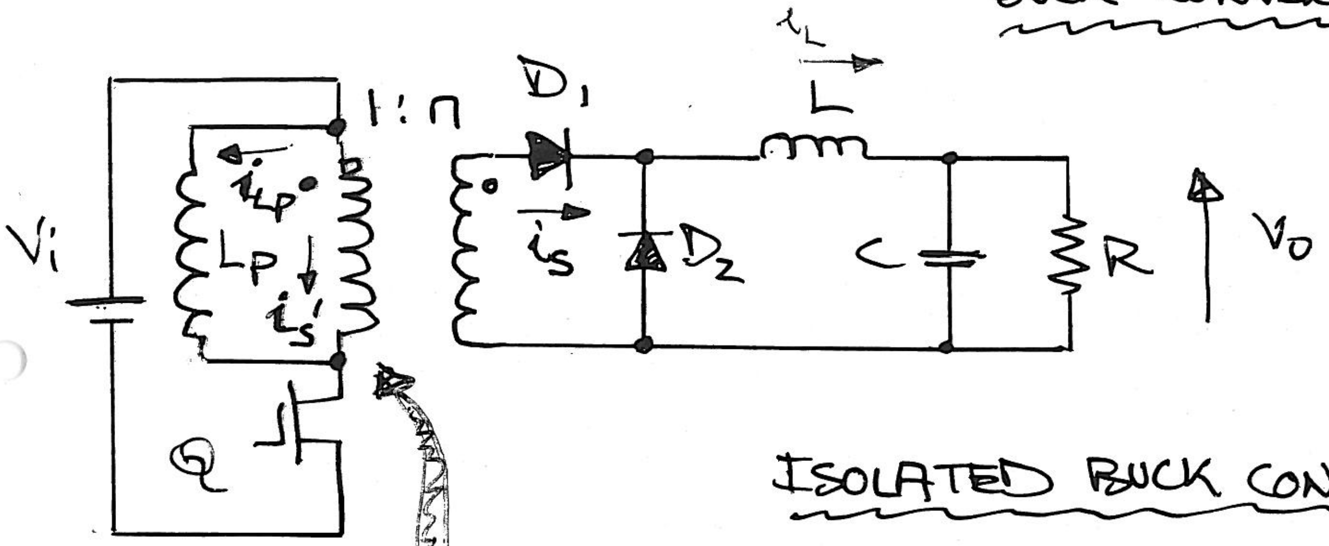
$$L_m \geq \frac{0.167}{(1/60)^2}\left(1-\frac{1}{2}\right)^2 \frac{10 \times 10^{-6}}{2} \text{ H}$$

$$\Rightarrow \quad L_m \geq 751 \ \mu\text{H} \qquad (***)$$

ISOLATED BUCK OR FORWARD CONVERTER

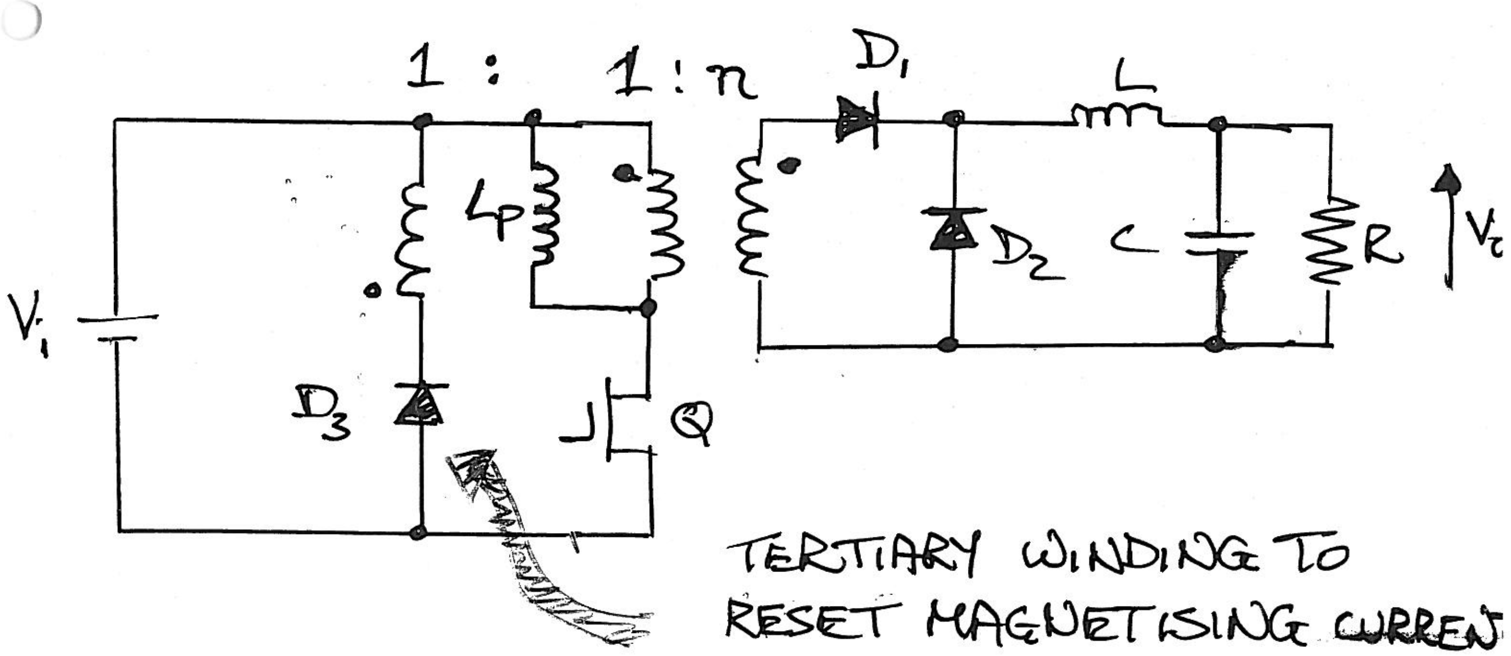


BUCK CONVERTER

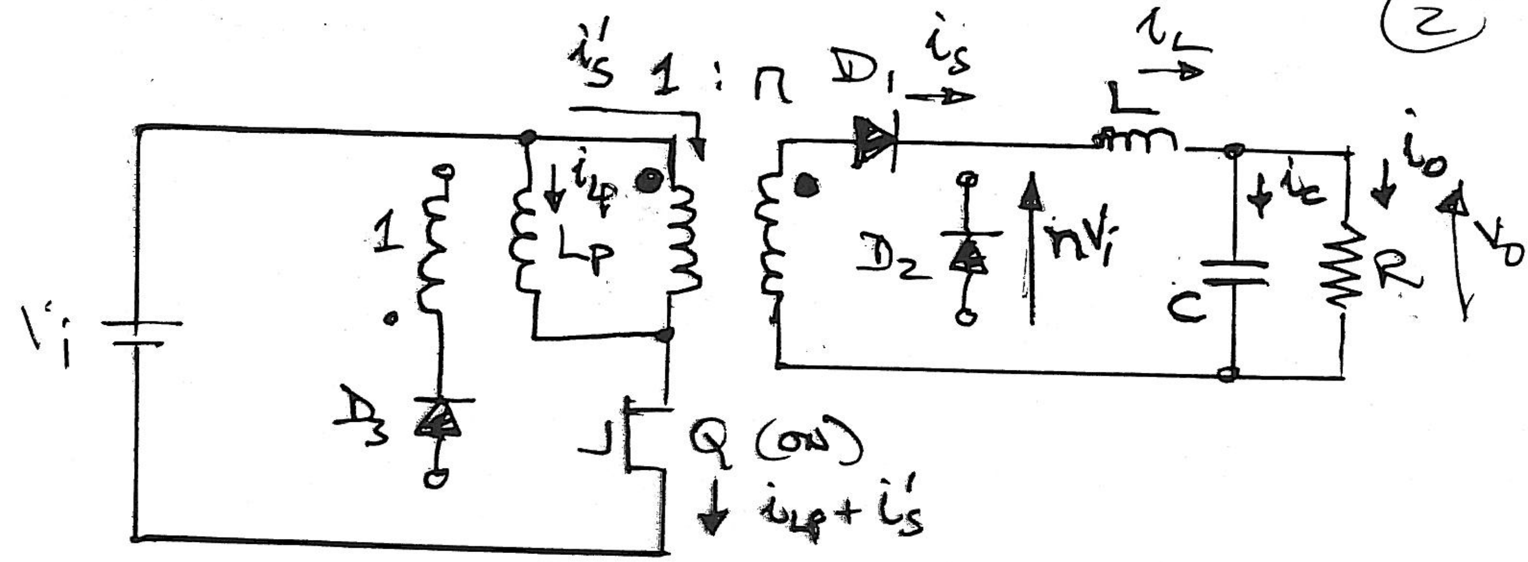


ISOLATED BUCK CONVERTER

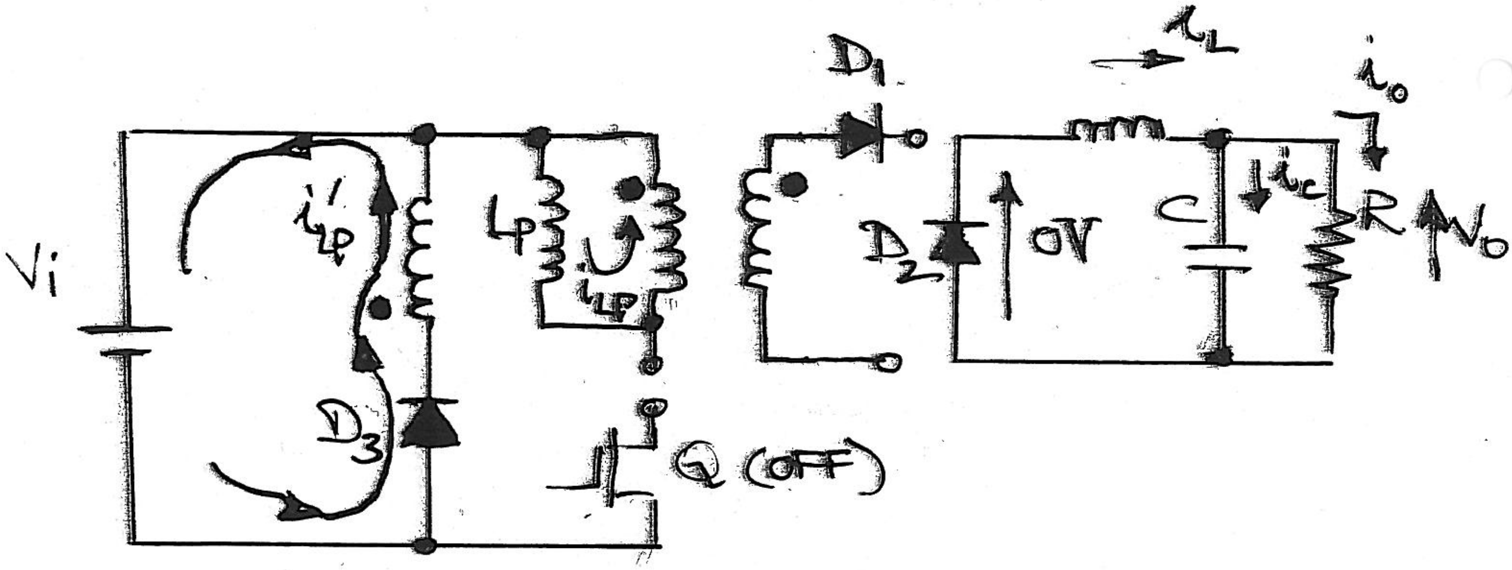
UNFORTUNATELY THE TRANSFORMER CORE MAGNETISING CURRENT HAS NO PATH TO FLOW WHEN Q TURNS OFF / CORE SEES NETT AVERAGE VOLTAGE / CORE SATURATES



TERTIARY WINDING TO RESET MAGNETISING CURRENT TO ZERO DURING OFF TIME.

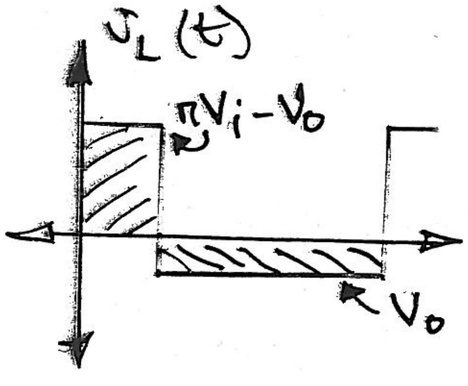


CURRENTS AND VOLTAGES DURING ON-TIME



CURRENTS AND VOLTAGES DURING OFF-TIME

* NOTE LIMIT ON D TO ALLOW ENOUGH TIME TO RESET i_{Lp}



* EQUATE OUTPUT INDUCTOR VOLT-SECONDS

$$(nV_i - V_o)\,t_{on} = V_o\,(T - t_{on})$$

$$\Rightarrow \frac{V_o}{V_i} = nD$$

* $I_{Lmax} - I_{Lmin} = \frac{V_o}{L}(1-D)T$

* EQUATE INPUT AND OUTPUT POWERS

$$P_i = P_o = \eta V_i \left(\frac{I_{Lmax} + I_{Lmin}}{2} \right) D$$

$$= V_o^2 / R$$

* HENCE SOLVE FOR I_{Lmax} AND I_{Lmin}.

FOR CONTINUOUS CONDUCTION

$$I_{Lmin} \geq 0$$

$$\Rightarrow \quad L \geq \left(\frac{1-D}{2} \right) TR$$

BE CAREFUL WITH SWITCH VOLTAGE DURING OFF TIME.

E.G. FOR EQUAL TURNS RATIO

$$V_Q = 2V_i$$