ECEN 4797/5797

Introduction to Power Electronics

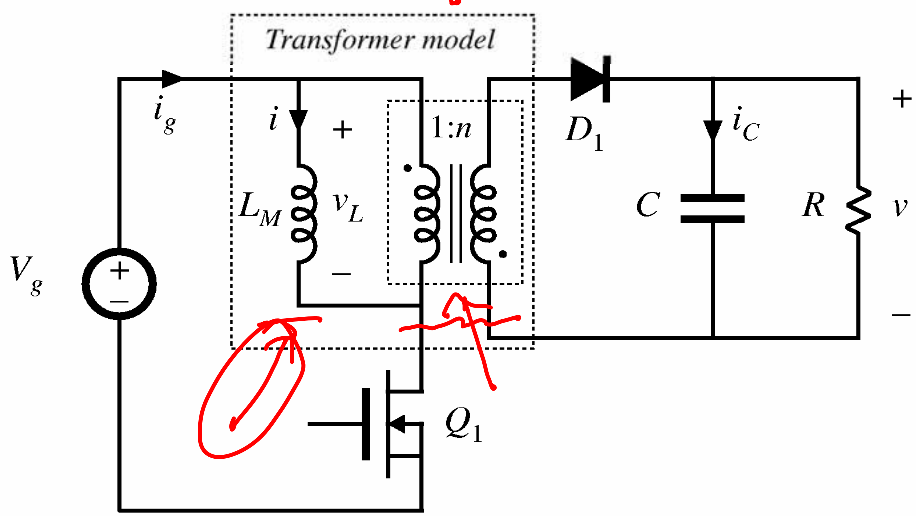
Lecture #18

Monday, October 5, 2009

Ch. 6: Transformer Isolation (Cont.)

Prof. Regan Zane

The "flyback transformer"



- A two-winding inductor
- Symbol is same as transformer, but function differs significantly from ideal transformer
- Energy is stored in magnetizing inductance
- Magnetizing inductance is relatively small

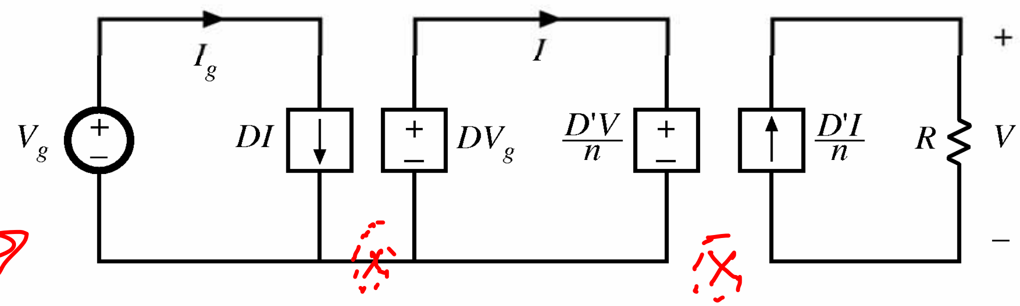
- Current does not simultaneously flow in primary and secondary windings
- Instantaneous winding voltages follow turns ratio
- Instantaneous (and rms) winding currents do not follow turns ratio
- Model as (small) magnetizing inductance in parallel with ideal transformer

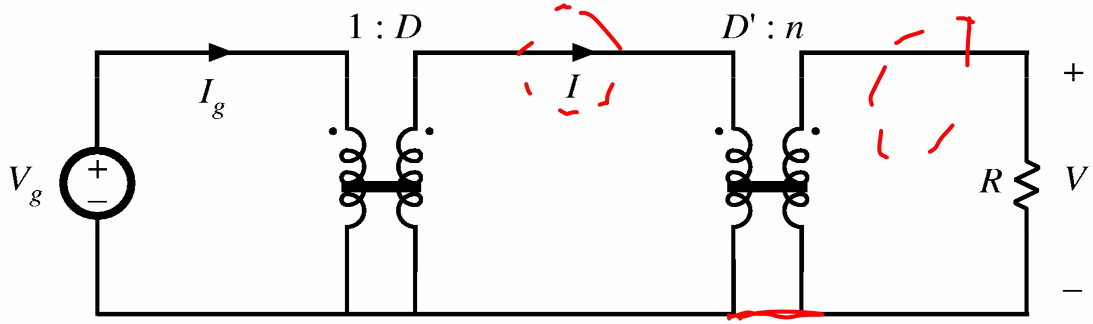
Equivalent circuit model: CCM Flyback

$$\langle v_L \rangle = D(V_g) + D'\left(-\frac{V}{n}\right) = 0$$

$$\langle i_C \rangle = D\left(-\frac{V}{R}\right) + D'\left(\frac{I}{n} - \frac{V}{R}\right) = 0$$

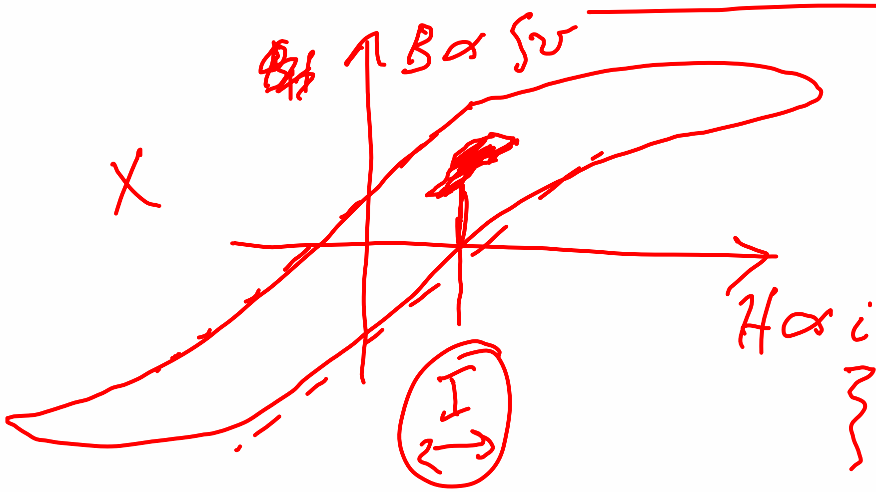
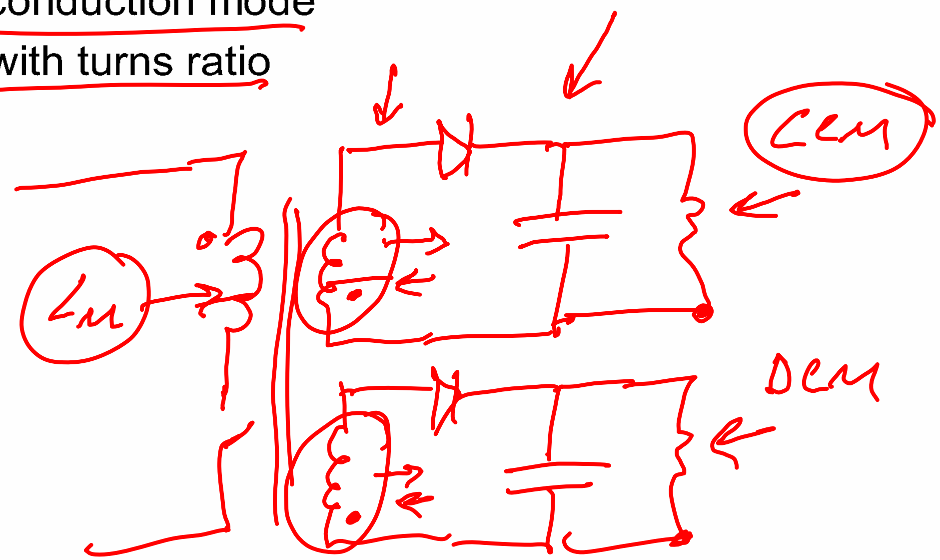
$$I_g = \langle i_g \rangle = D(I) + D'(0)$$





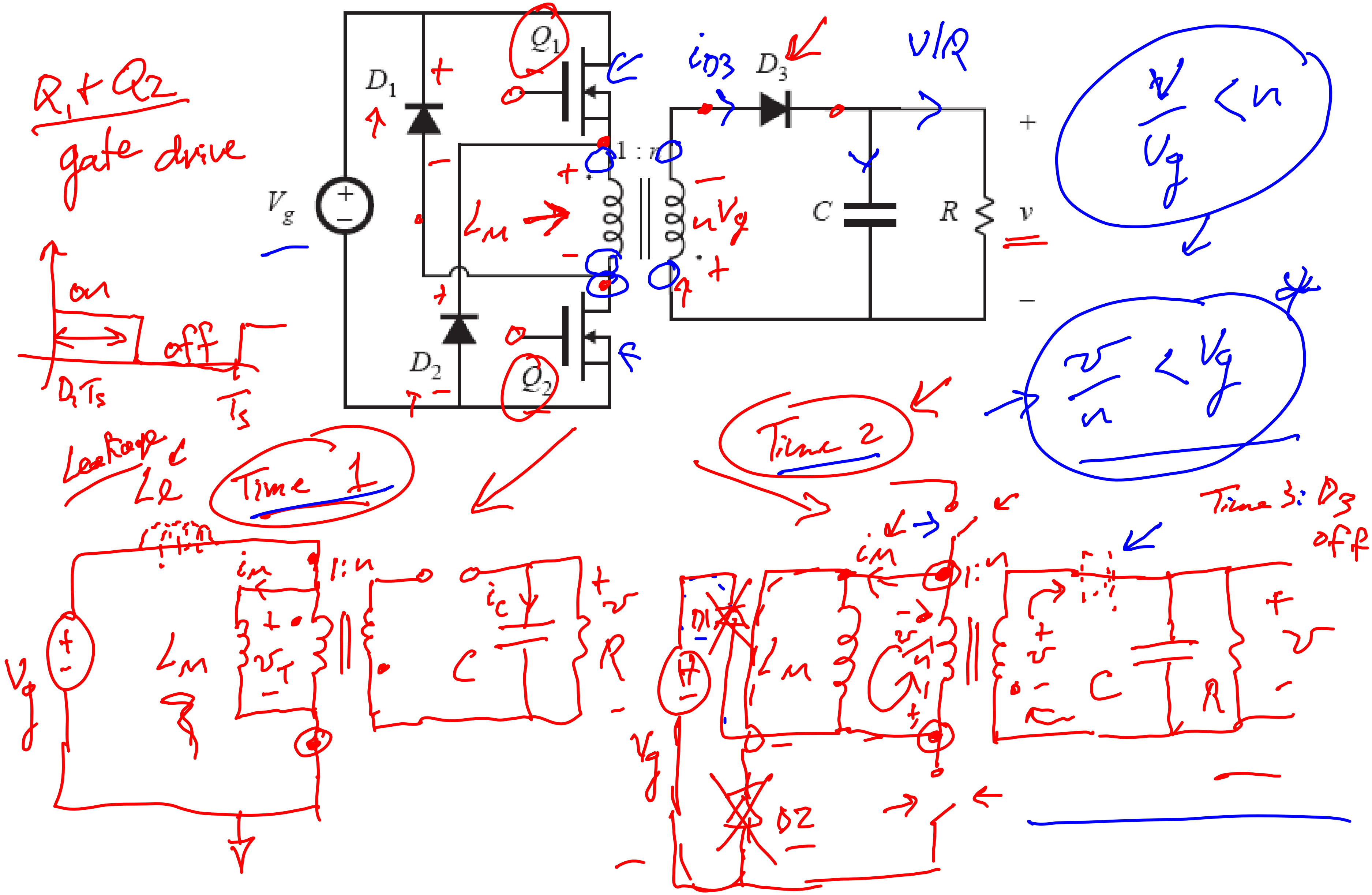
Discussion: Flyback converter

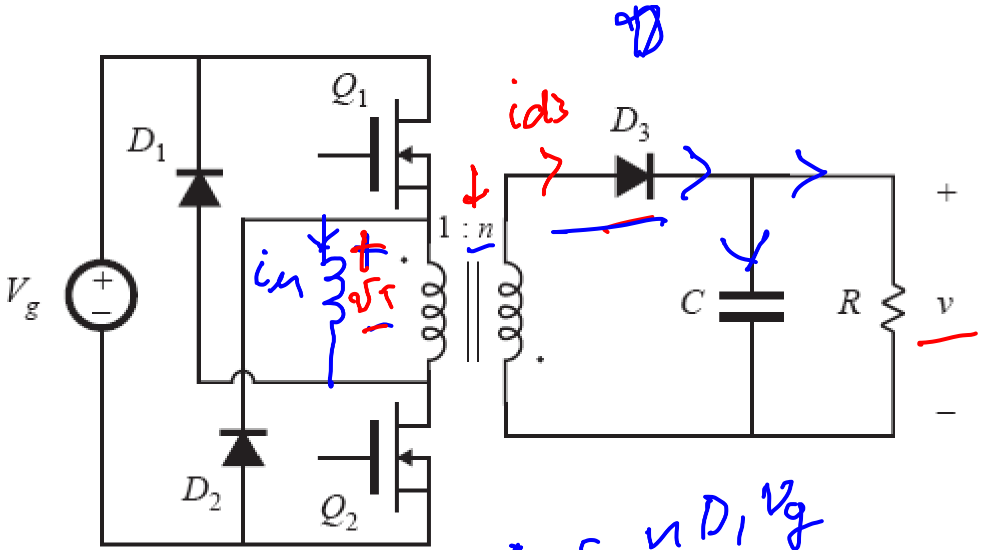
- Widely used in low power and/or high voltage applications
- Low parts count
- Multiple outputs are easily obtained, with minimum additional parts
- Cross regulation is inferior to buck-derived isolated converters
- Often operated in discontinuous conduction mode
- DCM analysis: DCM buck-boost with turns ratio

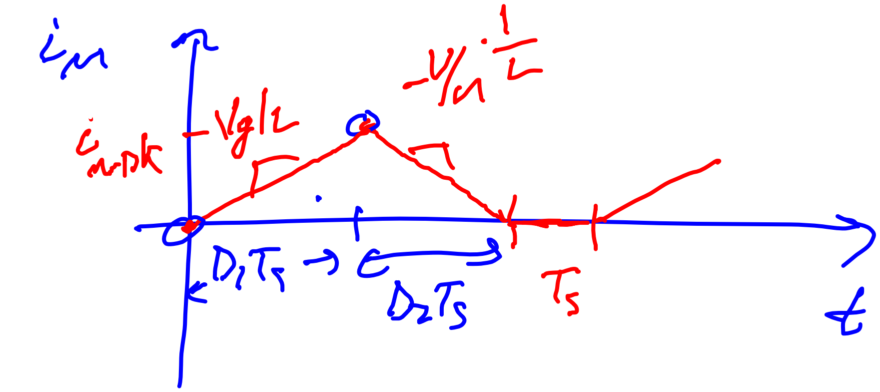



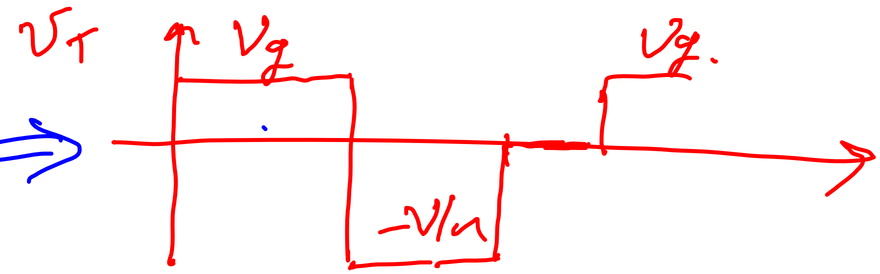
2-Transistor Flyback

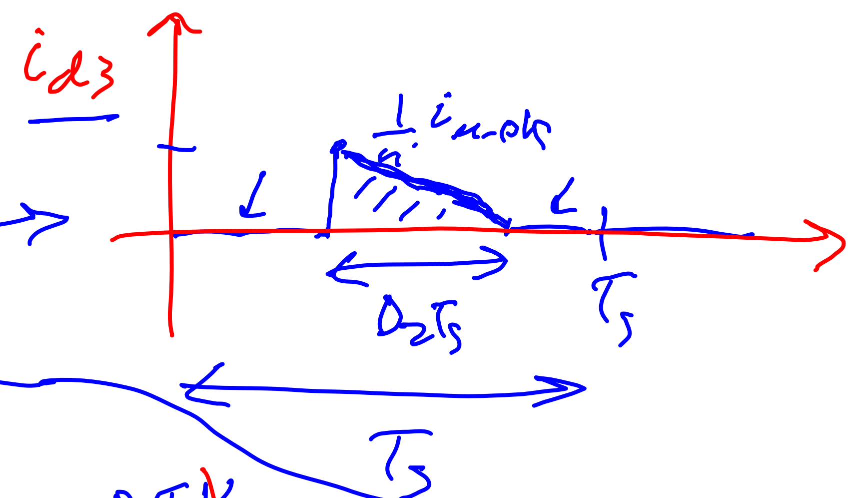
Text. 6.4 Prob.











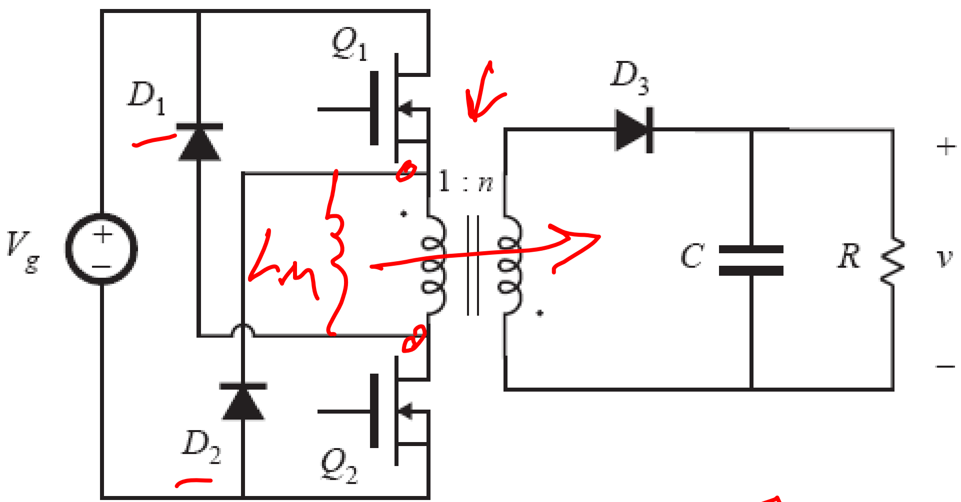
DCM:

$$D_1 V_g - \frac{D_2 V}{n} = 0 \rightarrow D_2 = \frac{n D_1 V_g}{V}$$

$$\langle i_{d3} \rangle = \frac{1}{T_s} \cdot \frac{1}{2} \cdot D_2 \cdot T_s \cdot \frac{i_{M\_pk}}{n}$$

$$= \frac{D_2}{2n} \cdot \frac{D_1 T_s V_g}{L} = \frac{V}{R}$$

$$= \frac{n D_1 V_g}{V\, 2n} \cdot \frac{D_1 T_s V_g}{L} = V/R$$



DCM

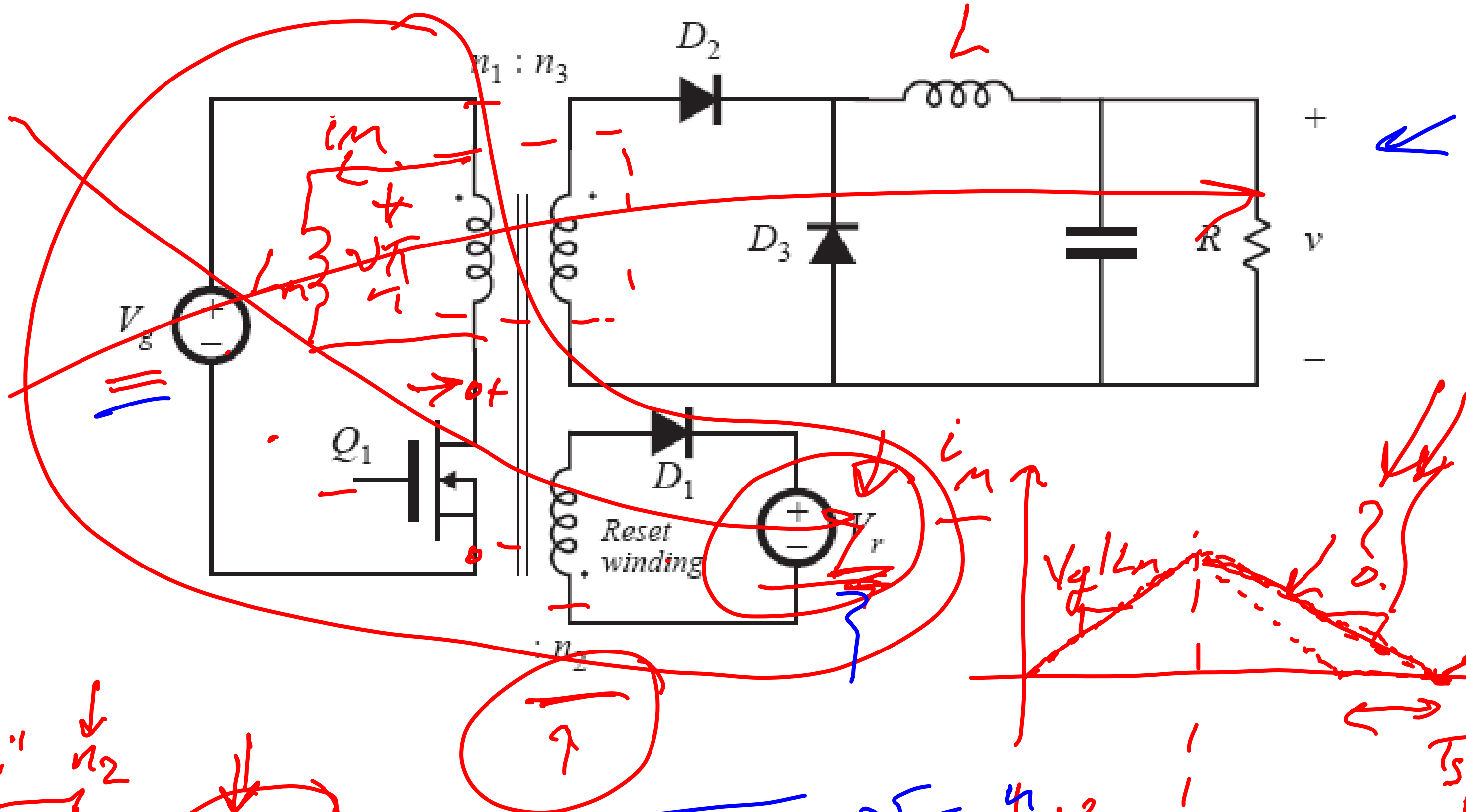
$$K = \frac{2L}{RT_s}$$

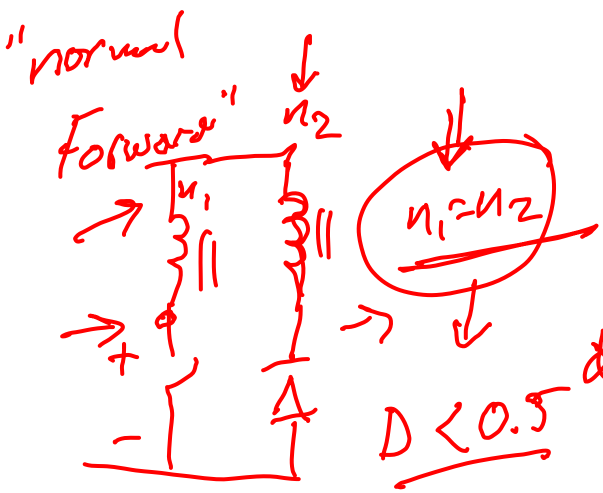
$$\frac{V}{V_g} = D_1 \sqrt{\frac{RT_s}{2L_m}} = nD_1 \sqrt{\frac{RT_s}{2n^2 L_m}}$$

$$\boxed{\frac{V}{V_g} = n\, D_1 \cdot \frac{1}{\sqrt{K}}} < n$$

$$\frac{V}{V_g} < n \rightarrow \boxed{D_1 < \sqrt{K}}$$

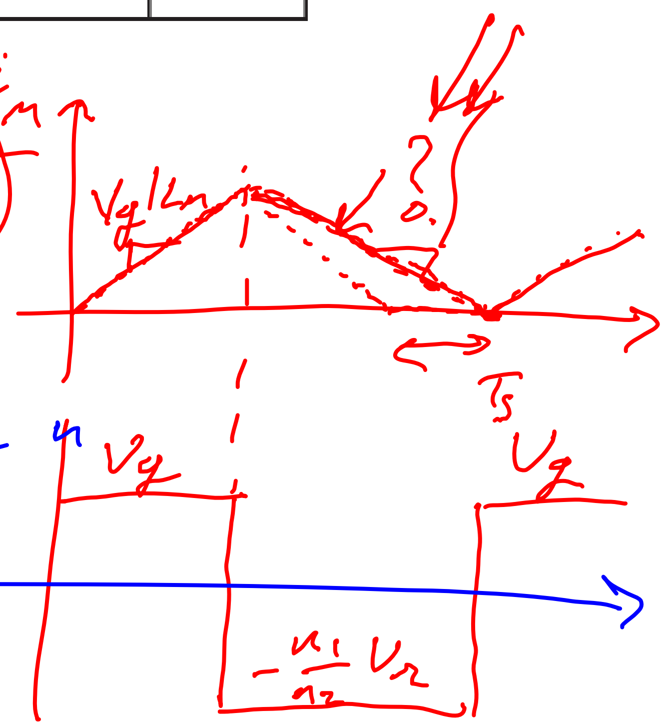
Forward converter w/ active reset (P6.9)

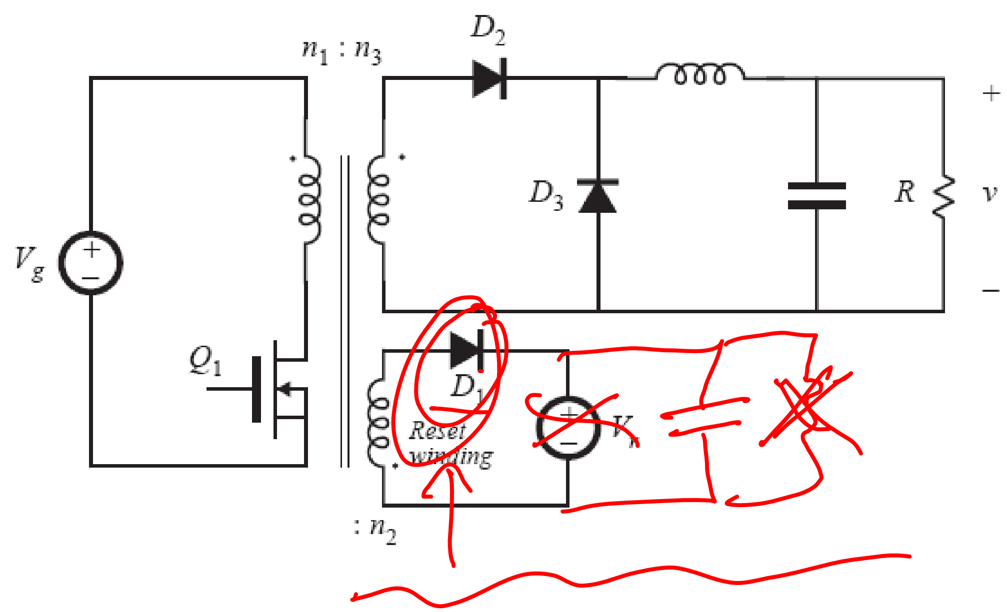




$$D V_g - \frac{n_1}{n_2} D' V_r = 0$$

$$V_r = \frac{n_2}{n_1} \cdot \frac{D}{D'} \cdot V_g$$





D2
n1 : n3
D3
R
v
+
–
Vg
Q1
D1
Reset winding
: n2