Power Electronics Education
Electronic Book

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Tutorial 7: Isolated DC-DC Converters

Presenter: Dr. Firuz Zare

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Q1: Find a conversion ratio of a flyback converter with a real switch $V_S=k_1$ and a real diode. $V_D=k_2$.

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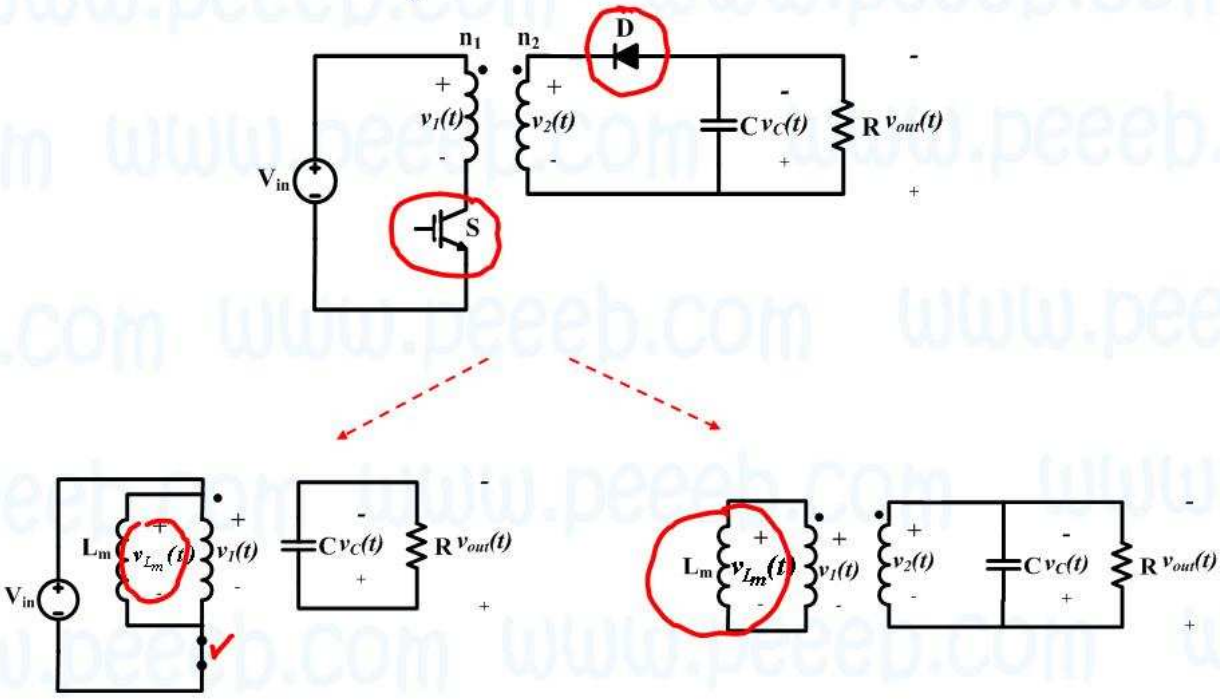
Flyback Converter



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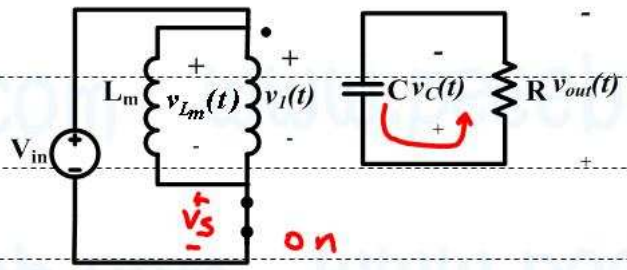
$v_1(t) = V_{in} - V_S$ on

$i_c(t) = -i_{out}$



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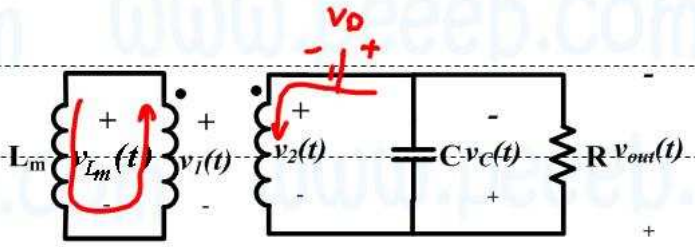


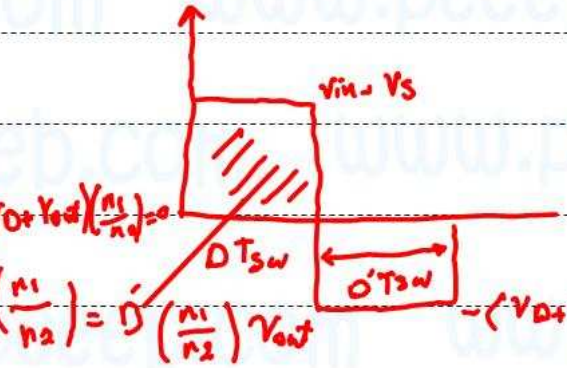
$v_2 = -v_D - v_{out}$

$\frac{n_1}{n_2} = \frac{v_1}{v_2}$

$v_1 = \left(\frac{n_1}{n_2}\right)(-v_D - v_{out})$

$v_1 = v_{Lm} = -\left(\frac{n_1}{n_2}\right)(v_D + v_{out})$ $\qquad \overline{v_{Lm}} = 0$

$$\overline{v_L} = 0$$



$$DT_{sw}(V_{in}-V_S) - D'T_{sw}(V_D+V_{out})\left(\frac{n_1}{n_2}\right)=0$$

$$DV_{in} - DV_S - D'V_D\left(\frac{n_1}{n_2}\right) = D'\left(\frac{n_1}{n_2}\right)V_{out} - (V_D+V_{out})\left(\frac{n_1}{n_2}\right)$$

$$\frac{V_{out}}{V_{in}} = \frac{D}{D'\left(\frac{n_1}{n_2}\right)} - \frac{DV_S}{D'\left(\frac{n_1}{n_2}\right)V_{in}} - \frac{V_D}{V_{in}}$$

$$\frac{V_{out}}{V_{in}} = \frac{D}{D'}\times\left(\frac{n_2}{n_1}\right) - \frac{D}{D'}\times\left(\frac{n_2}{n_1}\right)\left(\frac{V_S}{V_{in}}\right) - \frac{V_D}{V_{in}}$$

Q2: In a forward converter, turns ratio N_1/N_2 should be maximum. Find the turns ratios N_1/N_3 and N_1/N_2.

V_{in}= 100-140 V

V_{out}=10 V

N_1/N_2 <7

N_3/N_1>2

$$\frac{V_{out}}{V_{in}} = \frac{N_2}{N_1} \times D$$

$$\frac{10}{100} = \frac{N_2}{N_1} \times D \Rightarrow \frac{N_1}{N_2} = 10 \times D$$

$$\frac{10}{140} = \frac{N_2}{N_1} \times D \Rightarrow \frac{N_1}{N_2} = 14 \times D$$

$$D_{max} = \frac{1}{1 + \frac{N_3}{N_1}} = \frac{1}{1+2} = \frac{1}{3} = 0.33$$

$D = 0.33$

$\frac{N_1}{N_2} = 10 \times D = 10 \times 0.33 = 3.3$ ✓?

$\frac{N_1}{N_2} = 14 \times D = 14 \times 0.33 = 4.62$?

$\frac{10}{400} = \frac{1}{3.3} \times D \Rightarrow D = 0.33$

$\frac{10}{140} = \frac{1}{3.3} \times D \Rightarrow D = 0.237 < 0.33$

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