IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-12

Single-phase Boost PFC Converter-IV

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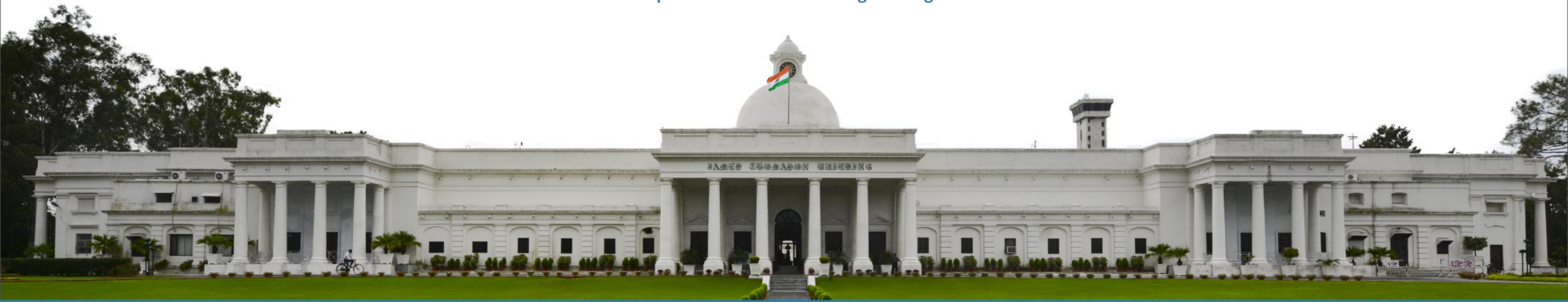
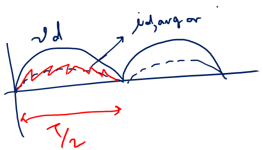
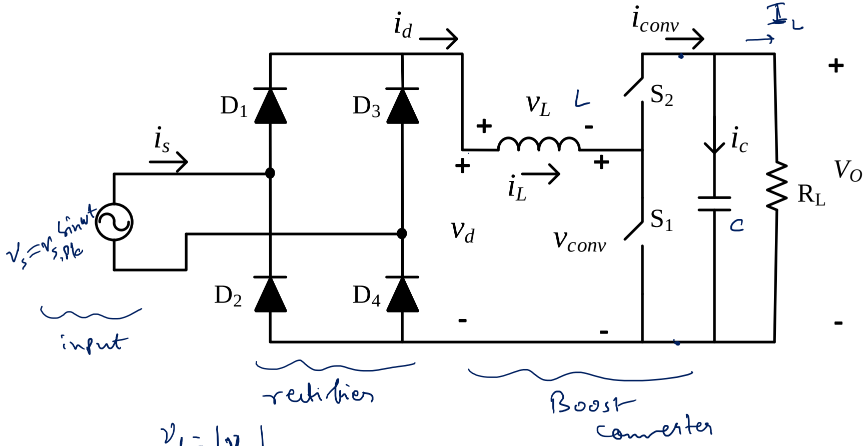


Recap



$$d(t) = 1 - \frac{|v_{s,pk} \sin \omega t|}{V_o}$$

$i_s = i_d$



$$L = \frac{V_o}{4 \Delta i_{L,max} f_{sw}} \rightarrow f_{sw} >> f_s$$

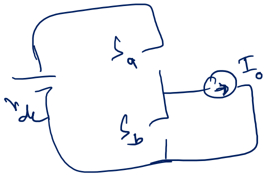
$$C = \frac{P_L}{2\pi f_s \Delta V_o \cdot V_o} \rightarrow \text{double line frequency component}$$

$v_d = |v_s|$

$$I_{S1,rms} = \sqrt{\frac{1}{T/2} \int_0^{T/2} (i_s(t))^2 \cdot d(t) \cdot dt} \rightarrow V_{s1} > V_o \approx v_{s1} = 1.4 V_o$$

$T = 1/f_s$

$$I_{rms,Sa} = I_o \sqrt{D} \longrightarrow$$



for Switch S_2

$(1-d(t))T_s \rightarrow S_2$ conducts

whenever S_1 is ON $\Rightarrow$ V_{S_2} has to block V_o

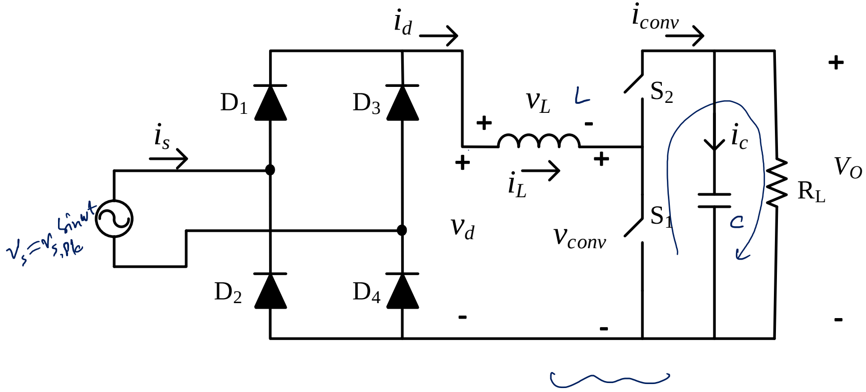
$\approx V_{S_2} = 1.4 V_o$

$$I_{rms,S_2} = \sqrt{\frac{1}{T/2}\int_0^{T/2} \left((i_s(t))^2 \cdot (1-d(t)) \right) \cdot dt}$$

$$= \sqrt{\frac{1}{T/2}\int_0^{T/2} \left((I_{s,pk} \sin\omega t)^2 \left(1 - \left(1 - \frac{|V_{s,pk} \sin\omega t|}{V_o}\right)\right)\right) \cdot dt}$$

$$I_{rms,S_2} = \sqrt{\frac{1}{T/2}\int_0^{T/2} (I_{s,pk} \sin\omega t)^2 \left(\frac{|V_{s,pk} \sin\omega t|}{V_o} \right) \cdot dt}$$

$$I_{avg,S_2} = \frac{1}{T/2}\int_0^{T/2} \left(i_s(t) \quad (1-d(t)) \right) \cdot dt$$



for diodes

$V_{RRM} = V_{s,pk}$

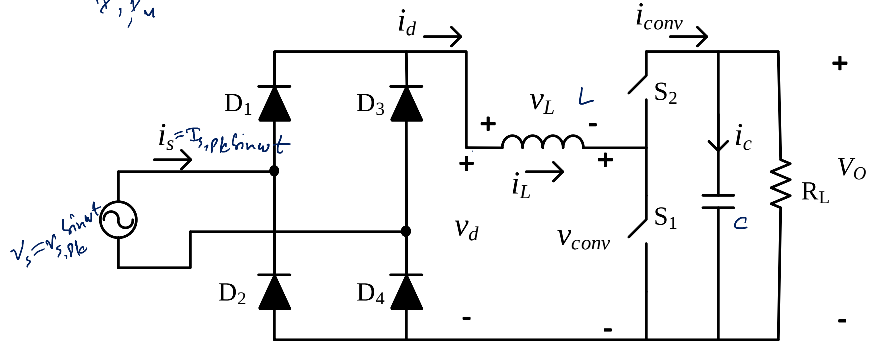
forward RMS current $= \sqrt{\frac{1}{T}\int_0^{T/2} (I_{s,pk} \sin\omega t)^2 \cdot dt}$

$= \frac{I_{s,pk}}{2}$

forward average current $= \frac{1}{T}\int_0^{T/2} I_{s,pk} \sin\omega t \cdot dt$

$= \frac{I_{s,pk}}{\pi}$

$D_1, D_4 \rightarrow 0 \text{ to } T/2$



$v_d = (V_{s,pk} \sin\omega t)$

RMS current of Capacitor & Inductor

For Inductor

$i_L = i_d$

$\Rightarrow i_d = i_s$ (in +ve)

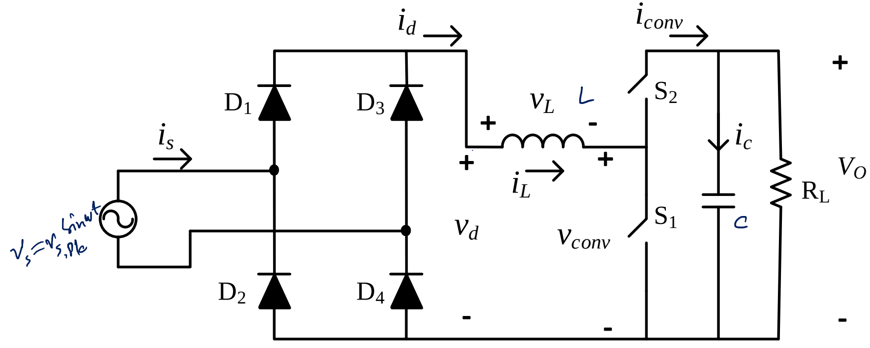
$= -i_s$ (-ve)

$$I_{L,rms} = \sqrt{\frac{1}{T/2}\left[\int_0^{T/2} \left((i_s(t))^2 \cdot d(t)\right) dt + \int_0^{T/2} (i_s(t))^2 (1-d(t)) \cdot dt\right]}$$

$$= \sqrt{\frac{1}{T/2}\int_0^{T/2} (i_s(t))^2 \cdot dt}$$

$$= \sqrt{\frac{1}{T/2}\int_0^{T/2} (I_{s,pk}\sin\omega t)^2 \cdot dt}$$

$$I_{L,rms} = \frac{I_{s,pk}}{\sqrt{2}}$$



P_L

$\Rightarrow P_{in} = \frac{P_L}{\eta}$

$\Rightarrow P_{in} = \frac{V_{s,pk}}{\sqrt{2}} \cdot \frac{I_{s,pk}}{\sqrt{2}}$

$\Rightarrow I_{s,pk} = \frac{2P_{in}}{V_{s,pk}}$

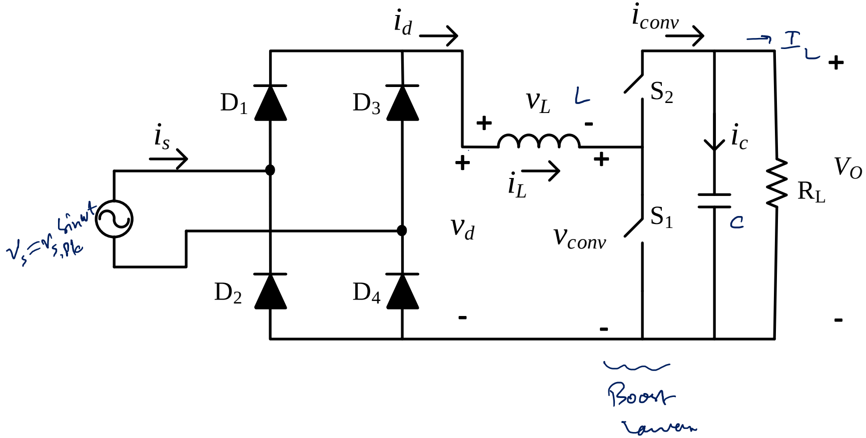
For Capacitor

$$I_{rms,conv} = I_{rms,S2}$$

$$\Rightarrow I_{conv} = i_c + I_L$$

$$\Rightarrow I_{rms,c} = \sqrt{I_{rms,conv}^2 - I_L^2}$$

$$I_{rms,conv} \rightarrow I_{rms,S2} \qquad I_L \rightarrow \left(\frac{V_o}{R_L}\right)$$



Thank You