IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-8

Revisiting Diode Bridge Rectifier with Capacitive Filter-II

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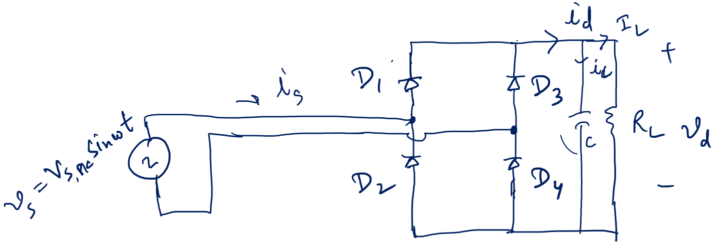
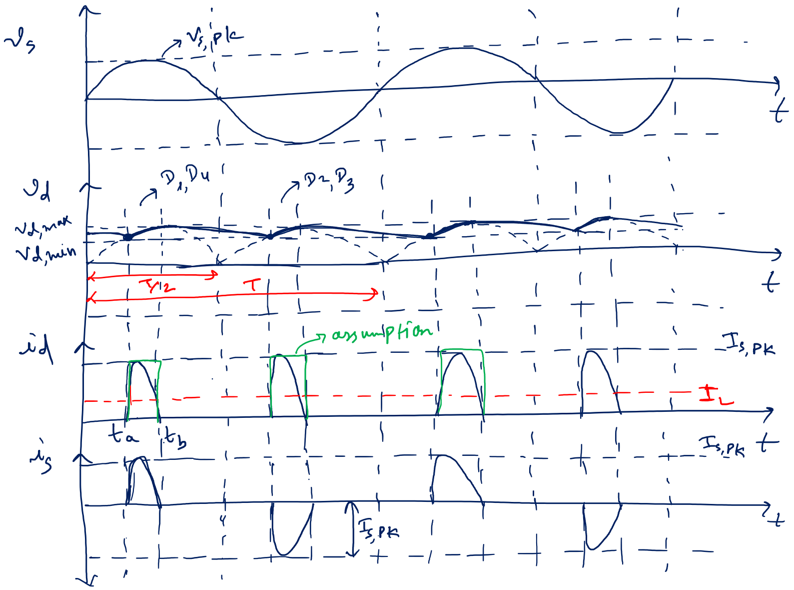


$$C = \left(1 - \frac{t_c}{T/2}\right) \times \frac{P_L}{2V_o \cdot \Delta V_o} \times \frac{1}{f_s}$$

$$t_c = t_b - t_a$$

$$V_o = \frac{V_{d,max} + V_{d,min}}{2}$$

$$\Delta V_o = V_{d,max} - V_{d,min}$$



$$T = 1/f_s$$

$$\omega = 2\pi f_s$$

$$\Rightarrow \omega T = 2\pi$$

$$I_L = \frac{P_L}{V_0}$$

$$I_L = I_{s,pk} \frac{t_c}{T/2}$$

$$\Rightarrow \quad I_{s,pk} = \frac{T/2}{t_c} \cdot \frac{P_L}{V_0}$$

$$\Rightarrow \quad I_{s,pk} = \frac{T/2}{t_c} \cdot \frac{P_L \times 2}{V_{d,max} + V_{d,min}}$$

$\Rightarrow$ if $V_{d,max} \approx V_{d,min}$

$\Rightarrow$ $t_c \to 0$

$\Rightarrow$ $I_{s,pk} \to \infty$ (very high value)

During 't_c'

$$I_{c,rms} = (I_{s,pk} - I_L) \times \sqrt{\frac{t_c}{T/2}}$$

During '$t_c - T/2$'

$$I_{c,rms} = I_L \times \sqrt{1 - \frac{t_c}{T/2}}$$

$$\Rightarrow \quad I_{c,rms} = \sqrt{(I_{s,pk} - I_L)^2 \frac{t_c}{T/2} + I_L^2 \left(1 - \frac{t_c}{T/2}\right)}$$

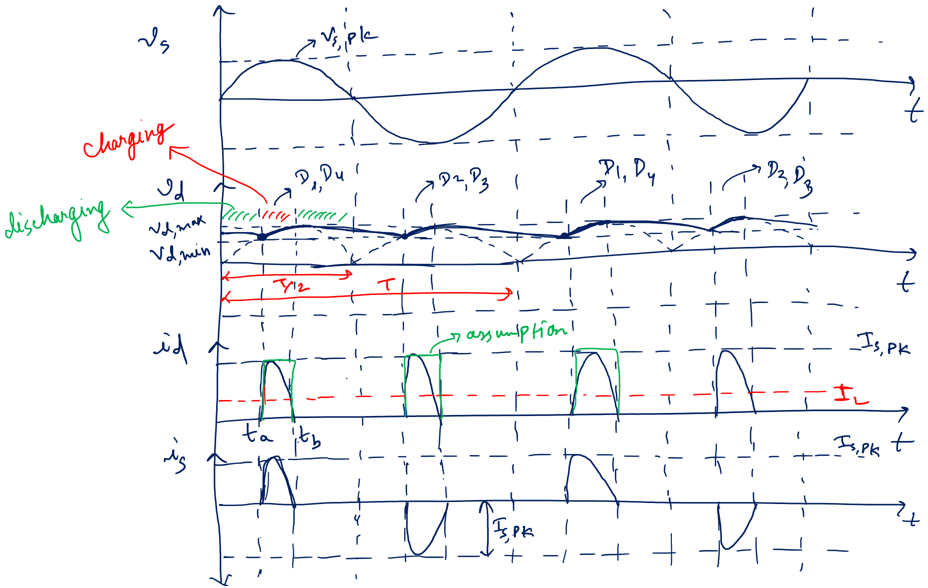
$\Rightarrow$ for Capacitor selection

→ Voltage rating of Capacitor $= v_o + \frac{\Delta v_o}{2} = V_{s,pk}$

→ $C = \left(1 - \frac{t_c}{T/2}\right) \times \frac{P_L}{2 v_o \cdot \Delta v_o} \cdot \frac{1}{f_s}$

→ RMS current rating $\Rightarrow I_{c,rms} = \sqrt{(I_{s,pk} - I_L)^2 \cdot \frac{t_c}{T/2} + I_L^2 \left(1 - \frac{t_c}{T/2}\right)}$

↳ determine the parallel-combination of Capacitance



Diode Selection

$$V_{RRM} = V_{s,pk} = v_o + \frac{\Delta v_o}{2}$$

Peak forward current $= I_{s,pk}$

Average forward current $= I_{s,pk} \times \frac{t_c}{T}$
D_1, D_2, D_3, D_4

RMS current $= I_{s,pk} \times \sqrt{\frac{t_c}{T}}$

$v_{d,max} \simeq v_{d,min}$

$\Rightarrow \Delta v_o \to 0$

$\to t_c \to 0$

$\Rightarrow C \uparrow$

$\Rightarrow I_{c,rms} \uparrow$

$\Rightarrow I_{s,pk} \uparrow$

Disadvantage

1. The peaky current drawn from the source, it includes a lot of harmonics.
2. The current drawn is at non-upf.
3. The oversizing of the components

Advantage

The output voltage is nearly constant (varying within the permissible limit)

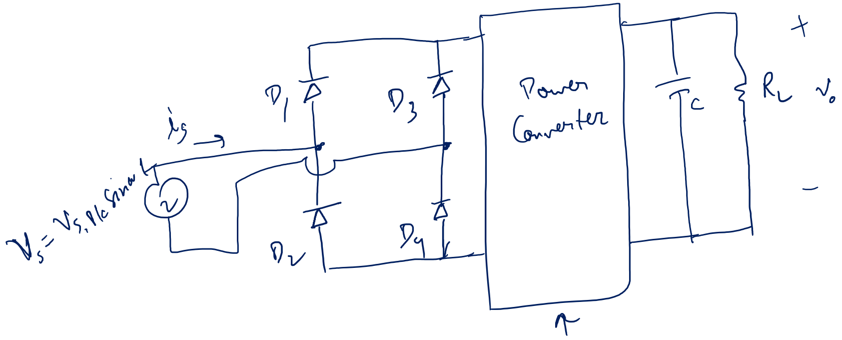
Learnings

① The unity power factor of the drawn current can be achieved when the load is purely resistive and the power is being delivered in both +ve and -ve half cycle.

② The output voltage can be made nearly constant (within the permissible limit) by putting the output capacitive filter,

↳ the current drawn becomes non-sinusoidal.

Thus, to obtain unity power factor current drawn along with regulated voltage, the power factor correction converter is used.



$v_s = V_{s,pk} \sin\omega t$
i_s
D_1
D_2
D_3
D_4
Power Converter
C
R_L
v_o
+
−

Thank You