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NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-7

Revisiting Diode Bridge Rectifier with Capacitive Filter

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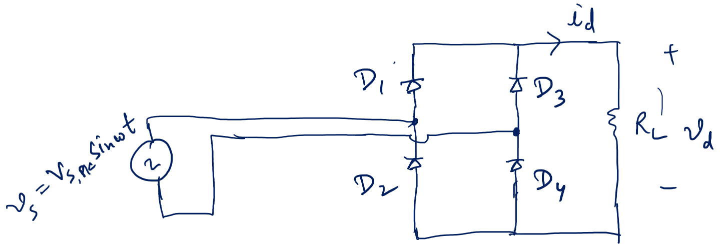
Recap



→ full-bridge uncontrolled rectifier

Inference

→ The output voltage is uncontrolled, it only depends on input AC voltage ($V_{s,pk}$)

→ The input current is sinusoidal in nature

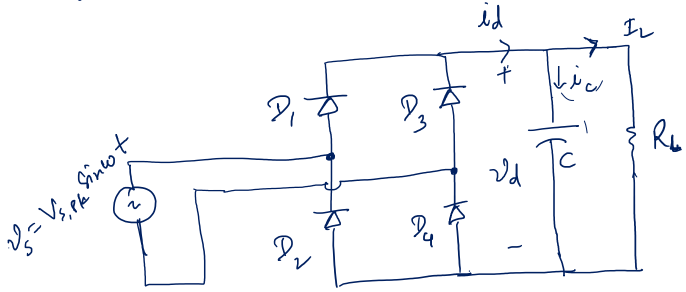
→ Power is delivered in both the cycle (+ve & −ve) to R_L.

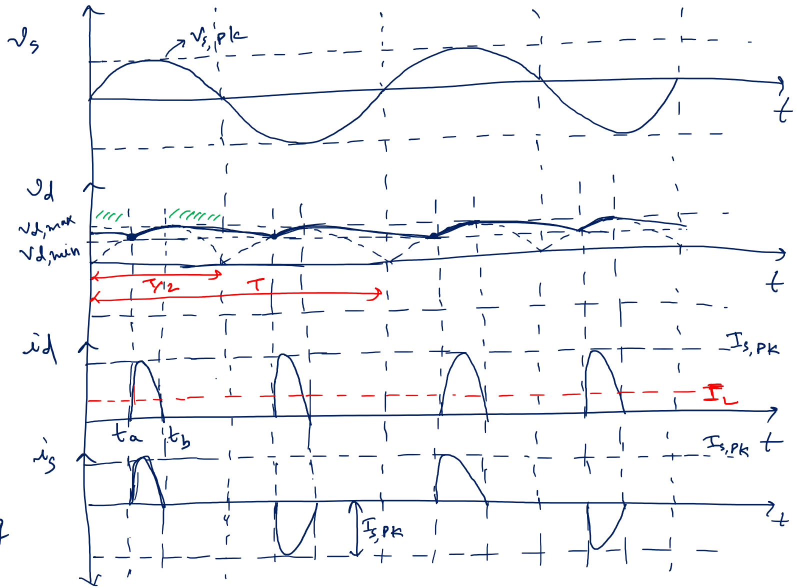
→ The output voltage is not constant, it is rectified DC voltage

$\Rightarrow v_d(t) = |v_s(t)|$

it is continuously varying

1-φ full-bridge rectifier with Capacitive filter





→ from t_a to t_b, the Capacitor 'C' is charging, while in the remaining portion of $T/2$, the capacitor is discharging

→ To maintain the voltage between $V_{d,max}$ & $V_{d,min}$ the energy gained during charging is equal to Energy lost during discharging

$T = 1/f_s$

$\omega = 2\pi f_s$

$\Rightarrow \omega T = 2\pi$

Energy gained during Charging $\Rightarrow E_c = \frac{1}{2} C \left(V_{d,max}^2 - V_{d,min}^2 \right) \longrightarrow$ (1)

Let, P_L be the load power (Power delived to load)

$\Rightarrow$ Energy delivered to load from Capacitor during $T/2$

$$E_d = P_L \times \frac{T}{2} \times \left[\frac{T/2 - t_c}{T/2} \right] \qquad [t_c = t_b - t_a]$$

$$E_d = P_L \times T/2 \times \left[1 - \frac{t_c}{T/2} \right] \longrightarrow (2)$$

$\Rightarrow$ $E_d = E_c$ (to ensure the capacitor voltage is between $V_{d,max}$ & $V_{d,min}$)

$$\Rightarrow \frac{1}{2} C \left(V_{d,max}^2 - V_{d,min}^2 \right) = P_L \times \frac{T}{2} \times \left[1 - \frac{t_c}{T/2} \right]$$

$$C = \left(1 - \frac{t_c}{T/2}\right) \times \frac{P_L}{(V_{d,max}^2 - V_{d,min}^2)} \times T \longrightarrow (3)$$

$$V_{d,max}^2 - V_{d,min}^2 = (V_{d,max} + V_{d,min})(V_{d,max} - V_{d,min}) \longrightarrow (4)$$

$\Rightarrow \quad \Delta V_o = V_{d,max} - V_{d,min}$ (output voltage ripple)

$\Rightarrow \quad \dfrac{V_{d,max} + V_{d,min}}{2} = V_o$ ($V_o \rightarrow$ nominal output DC voltage)

$$\Rightarrow \quad V_{d,max}^2 - V_{d,min}^2 = 2V_o \cdot \Delta V_o \longrightarrow (5)$$

Substitute (5) in (3)

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

$f_s \rightarrow 50\ Hz$

In order to Select the Capacitor

✓ → Capacitance value

✓ → voltage rating → $V_{d,max} = V_0 + \frac{\Delta V_0}{2}$

→ RMS current through the Capacitor → will determine the parallel connection in the Capacitor bank

Thank You