IIT ROORKEE

FREE ONLINE EDUCATION swayam शिक्षित भारत, उन्नत भारत

NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-5

Revisiting Diode Bridge Rectifier

Dr. Apurv Kumar Yadav

Department of Electrical Engineering

Recap

1. EV ecosystem → low voltage Batteries (48v - 72v)
   → High voltage Batteries (350v - 500v)
2. DC charger → DC EVSE (power conversion unit is kept outside the vehicle) → off-board charger
3. AC charger → AC EVSE (power conversion is taking place on the vehicle using an OBC)
4. Types of charger → modes of charging, charger plugs, level of charging station.

AC-DC Converters

AC-DC Converter Requirement/need

1. Conversion from AC voltage source to DC
2. The controlled/Regulated DC output voltage (the level of voltage can also be controlled) at the desired level
3. The current drawn from the source must have an unity power factor.
4. Current drawn must be having a sinusoidal (nearly) variation.
5. Harmonic content should be less means THD is less.

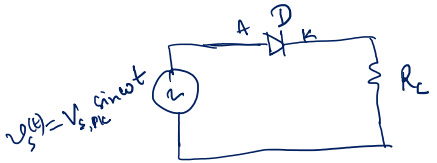
1-ϕ input, 1-ϕ AC-DC Converter

3-ϕ input, 3-ϕ AC-DC Converter

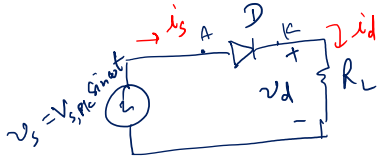
1-ϕ Diode Bridge Rectifier (uncontrolled Rectifier)

(i) Half-bridge Rectifier (ii) full-bridge Rectifier

1-ϕ Half-bridge rectifier with Resistive load



'D' turns on when the 'v_s' is in the positive half; it is reverse biased when 'v_s' is in the negative half cycle.



$$v_d = \begin{cases} v_s, & v_s > 0 \\ 0, & v_s < 0 \end{cases}$$

$\omega = 2\pi f_s$ (f_s = supply frequency)

$\Rightarrow T = 1/f_s$

$\Rightarrow \omega T = 2\pi$

average value of v_d, $V_{d,avg} = \frac{1}{T} \int_0^{T/2} (V_{s,pk} \sin \omega t) \cdot dt$

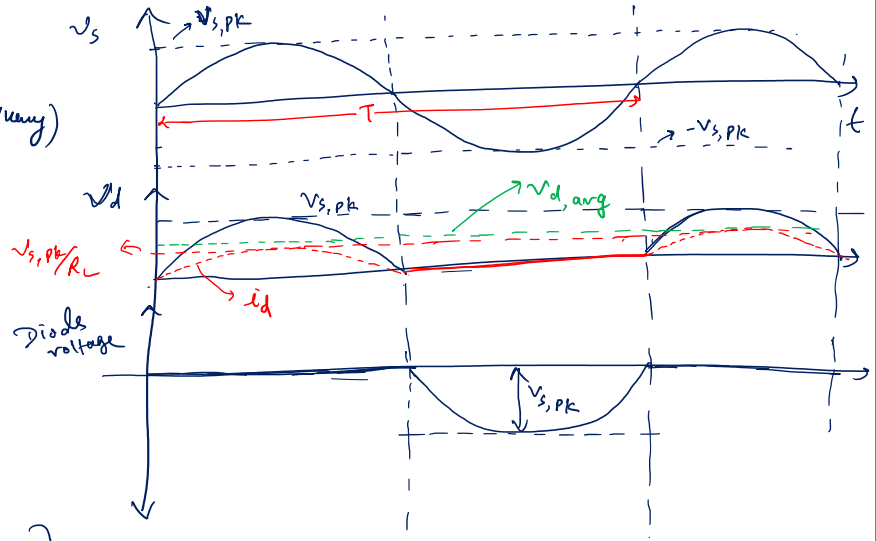
$$= \frac{V_{s,pk}}{\omega T} \left[-\cos \omega t \right]_0^{T/2}$$

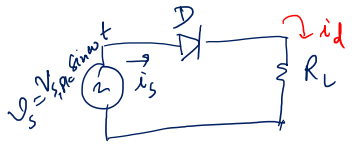
$$= \frac{V_{s,pk}}{\omega T} \left[-\left(\cos \frac{\omega T}{2} - \cos 0 \right) \right]$$

$$= \frac{V_{s,pk}}{2\pi} \left[-\left(\cos \pi - \cos 0 \right) \right]$$

$$= \frac{V_{s,pk}}{2\pi} \left[-(-1-1) \right]$$

$$\boxed{V_{d,avg} = \frac{V_{s,pk}}{\pi}}$$





$$i_s = \begin{cases} i_d & ; v_s > 0 \\ 0 & ; v_s < 0 \end{cases}$$

Diode selection

v/g ratings

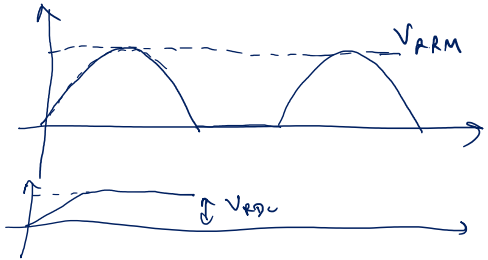
- Peak repeatitive reverse voltage (V_{RRM})
- Peak reverse voltage
- Reverse voltage or DC Blocking voltage

Current ratings

- Average forward current, $I_{F(av)}$
- Average rectified forward current
- Repeatitive peak forward current, I_{FRM}
- Non-Repeatitive peak forward current, I_{FSM}
- I^2t rating

$I \rightarrow$ Rms value of forward current

$t \rightarrow$ the time period of the pulse



Diode selection

voltage rating

- Peak repeatitive reverse voltage (V_{RRM}) $= V_{s,pk}$

- $I_{F,avg} = \dfrac{V_{s,pk}}{\pi R_L}$

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

$$I_{F,rms} = \frac{V_{s,pk}}{2R_L}$$

Thank You