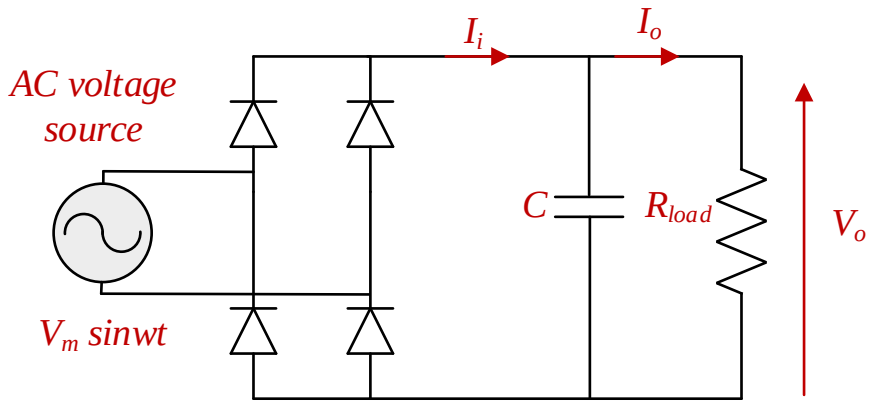
Power Electronics 1

Lab 1 (part 1)

Introduction

Both the half wave and full wave uncontrolled rectifiers provide a DC voltage from an AC voltage supply. However, it is more practical to use full wave uncontrolled rectifier because it produces low voltage ripples, thus needs a lower smoothing capacitance.

Full wave uncontrolled rectifier



Capacitor calculations

Assuming that the capacitor discharging current is linear with a frequency equals to double the AC supply frequency ($T_{discharging} \cong T$)

$$I_{load} = \frac{CdV}{dt} \cong C * \frac{V_{max} - V_{min}}{T} \cong C * \frac{V_{ripple}}{T}$$

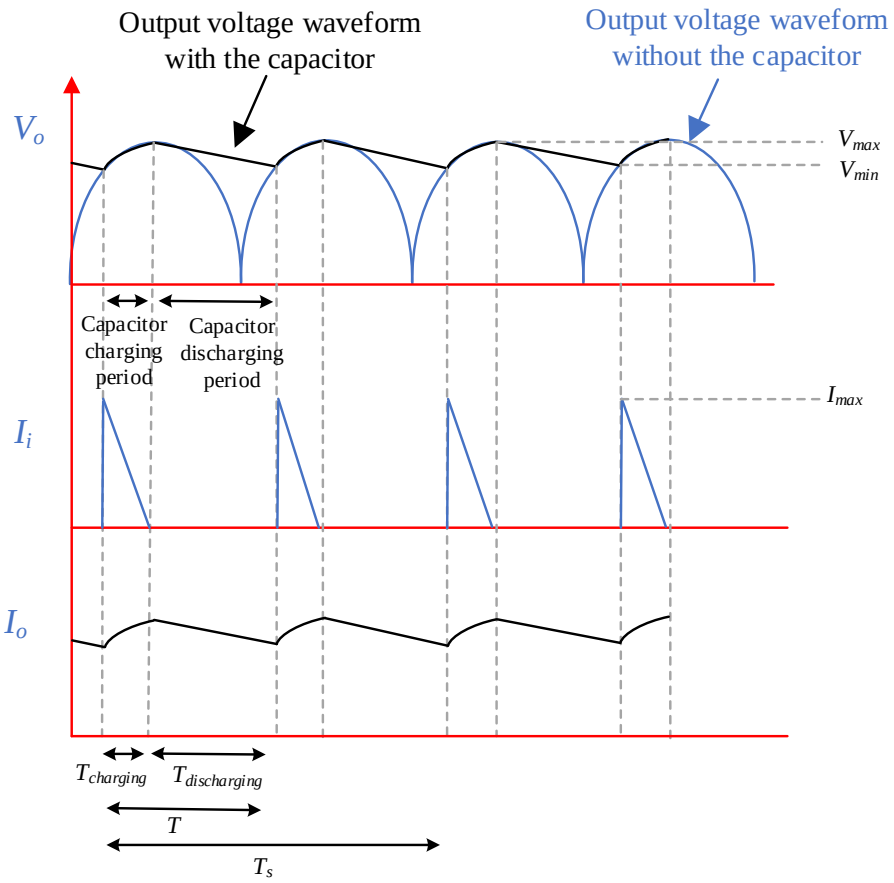
where T is the period of the full wave rectified waveform. The capacitance value can be calculated as follow:

$$\boldsymbol{C = \frac{I_{load}}{f * V_{ripple}}}$$

where the allowable capacitor voltage ripple should be less than 10% of the DC output voltage (V_o). Also, f is the frequency of the rectified voltage (double the frequency of the AC waveform) and I_{load} is the output load current.

The output voltage in case of using a smoothing capacitor can be approximately considered equals to the peak of the supply voltage.

$$V_o \cong V_m$$



It is worth noting that as the capacitor increases, the input maximum current also increases. Thus, keep in mind that an extremely large capacitance is not all good to the circuit

Also, to avoid high inrush current of the capacitor, either increase the supply voltage gradually or use a pre-charged capacitor.

The reverse voltage on the diodes

$$V_R = \frac{V_m}{2}$$

Then the chosen diode should have a reverse blocking voltage equal to at least double that value (practical consideration)

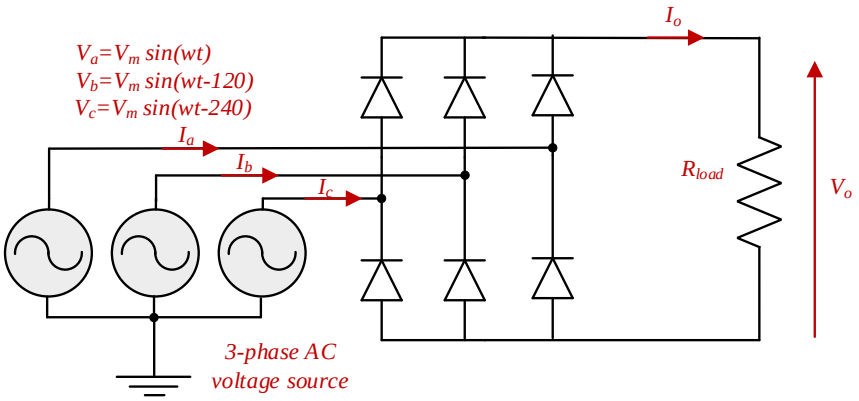
Power Electronics 1

Lab 1 (part 2)

Introduction

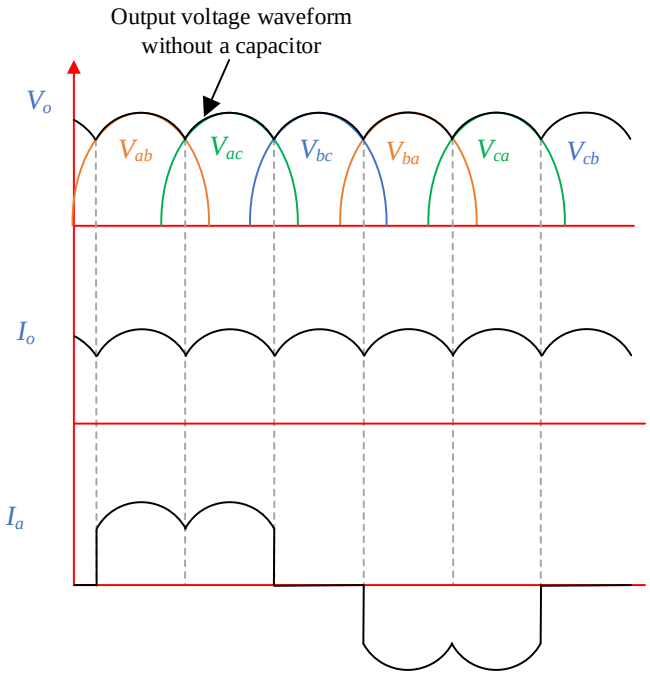
Three-phase full-wave uncontrolled rectifier is used to provide a DC voltage with acceptable voltage ripples without the need for a smoothing capacitor.

Three-phase full-wave uncontrolled rectifier



The DC component of the output voltage in case of a three-phase full-wave uncontrolled rectifier is given by;

$$V_o = \frac{3\sqrt{3}V_m}{\pi}$$



Requirements

- MATLAB Simulation on the full bridge rectifier circuit, with a suitable smoothing capacitor (Screen shots of the simulated circuit, measurements of the output voltage and input current).
- PCB or VERO board for the full bridge rectifier circuit, with a suitable smoothing capacitor.
- MATLAB Simulation on the three-phase uncontrolled rectifier circuit, (Screen shots of the simulated circuit, measurements of the output voltage and input current).
- PCB or VERO board for the three-phase uncontrolled rectifier circuit.

Instructions

- All PCB boards should have the number of the team written on it. Otherwise, the board will be held until the end of the submission week.
- At the submission day, the mark is given based on the PCB/VERO board, simulation, and a few oral questions

What each student should have learnt by the end of lab 1

- How the full wave uncontrolled rectifier works
- How to design the smoothing capacitor
- Revision on PCB board implementation
- How to read the data sheet of the diode
- Debugging a PCB circuit
- How the three-phase uncontrolled rectifier works.
- Benefits of using three-phase over single-phase rectifiers.