Experiment 4: Single and Three phase uncontrolled rectifier with Capacitor Filter

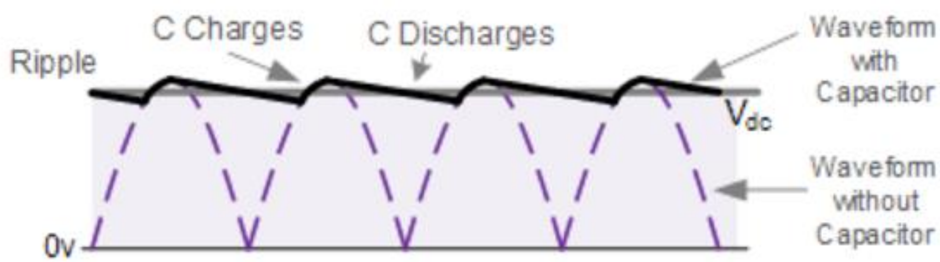
Introduction to the Experiment

This experiment is aimed to analyze the effect of capacitor filter or smoothing capacitor on rectified output voltage for both single phase and three phase uncontrolled rectifiers. The circuit is implemented in simulation as well as hardware and the performance is studied.

Learning outcomes:

Concept of Smoothing Capacitor:

We saw in the previous experiment that the single phase half-wave rectifier produces an output wave every half cycle and that it was not practical to use this type of circuit to produce a steady DC supply. The full-wave bridge rectifier however, gives us a greater mean DC value with less superimposed ripple while the output waveform is twice that of the frequency of the input supply frequency. We can therefore increase its average DC output level even higher by connecting a suitable smoothing capacitor across the output of the bridge circuit as shown below.



Resultant Output Waveform

The smoothing capacitor converts the full-wave rippled output of the rectifier into a smooth DC output voltage. Generally for DC power supply circuits the smoothing capacitor is an Aluminum Electrolytic type that has a capacitance value of 100uF or more with repeated DC voltage pulses from the rectifier charging up the capacitor to peak voltage.

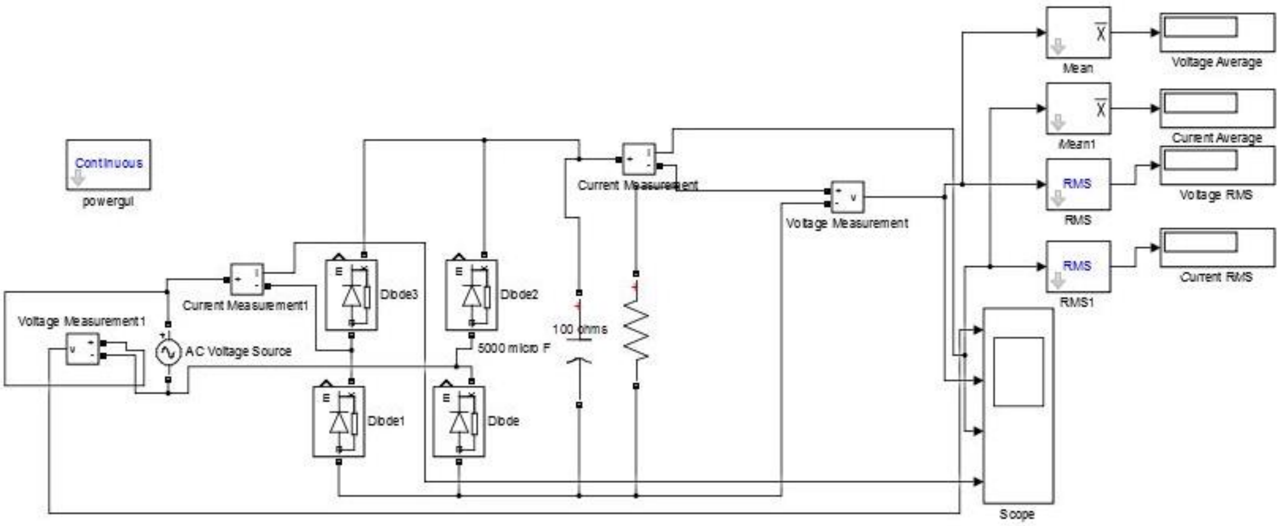
However, there are two important parameters to consider when choosing a suitable smoothing capacitor and these are its Working Voltage, which must be higher than the no-load output value of the rectifier and its Capacitance Value, which determines the amount of ripple that will appear superimposed on top of the DC voltage.

Too low a capacitance value and the capacitor has little effect on the output waveform. But if the smoothing capacitor is sufficiently large enough (parallel capacitors can be used) and the load current is not too large, the output voltage will be almost as smooth as pure DC. As a general rule of thumb, we are looking to have a ripple voltage of less than 100mV peak to peak.

The main advantages of a full-wave bridge rectifier is that it has a smaller AC ripple value for a given load and a smaller reservoir or smoothing capacitor than an equivalent half-wave rectifier. Therefore, the fundamental frequency of the ripple voltage is twice that of the AC supply frequency (100Hz) where for the half-wave rectifier it is exactly equal to the supply frequency (50Hz).

1 a). Simulation of full wave single phase diode Rectifier with C Filter

Aim: To simulate Single phase Diode Rectifier with Filter capacitor in MATLAB Simulink



PROBLEM 1:

a. Implement the 1-phase *uncontrolled* full wave rectifier with a Capacitor filter of **C = 5000µF** in parallel with the R load of **100 Ω** and observe the changes in the output voltage waveform. (Input voltage: 50V Peak = **35.35V (RMS) and 50Hz**)

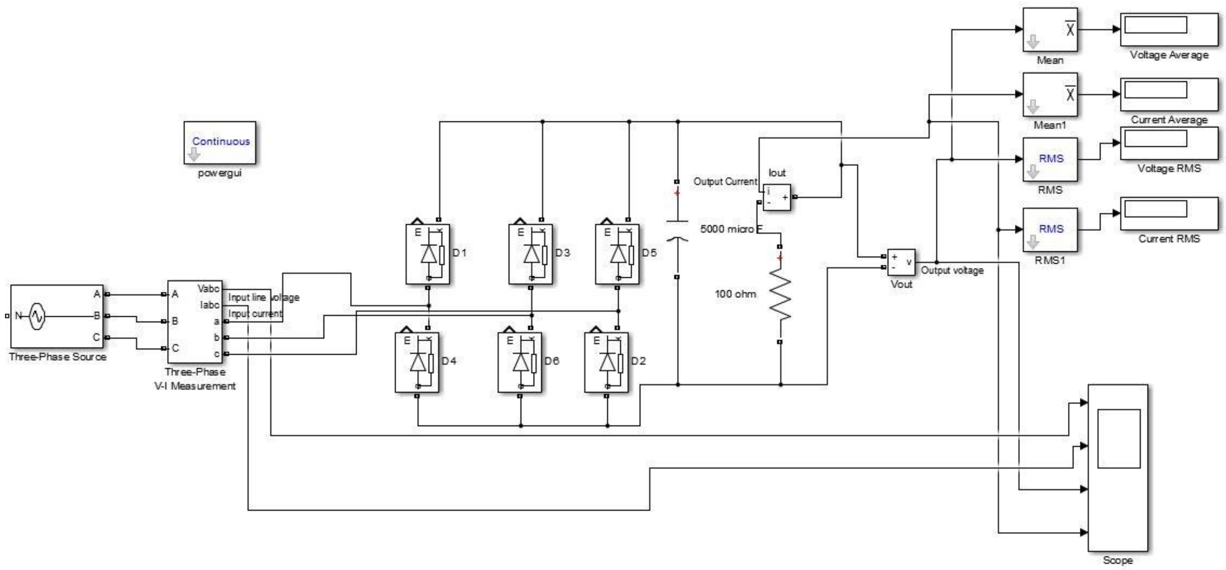
CALCULATION

Form Factor = V_{rms}/ V_{dc} =

Ripple Factor = $\sqrt{FF^2 - 1}$ =

1 b). Simulation of full wave Three phase diode Rectifier with C Filter

Aim: To simulate Three phase Diode Rectifier with Filter capacitor in MATLAB Simulink



PROBLEM 2:

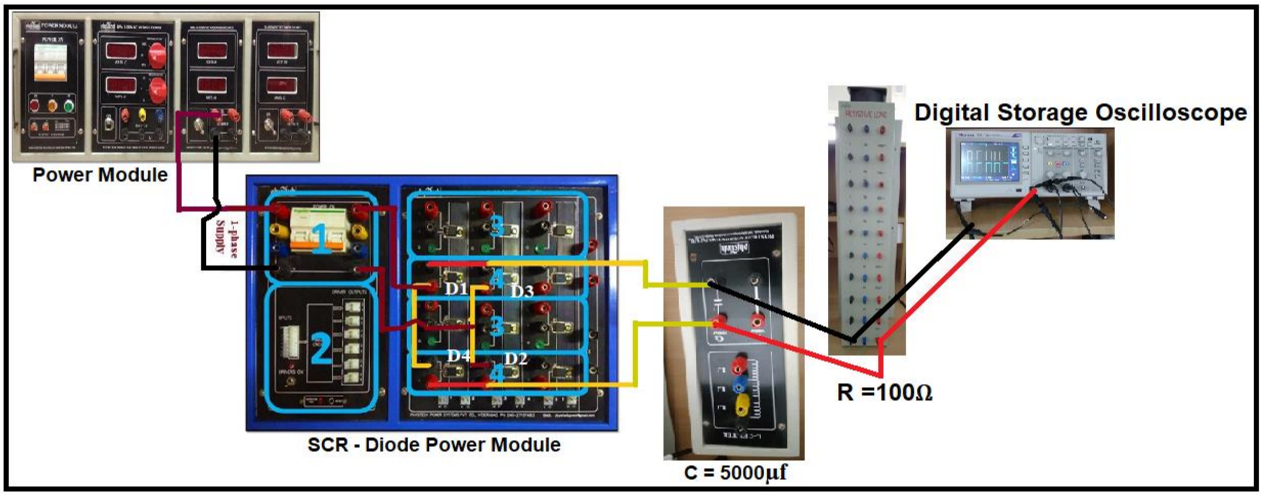
Implement the 3-phase *uncontrolled* full wave rectifier with a Capacitor filter of **C = 5000µF** in parallel with the R load of $\mathbf{100\ \Omega}$ and observe the changes in the output voltage waveform. (Input voltage: Phase-to-phase RMS voltage (V) = $\mathbf{61.2\ V}$**, 50Hz**)

CALCULATION

Form Factor = $V_{rms}/\ V_{dc}$ =

Ripple Factor = $\sqrt{FF^2 - 1}$ =

2.a) Hardware Implementation full wave single phase diode Rectifier with C Filter



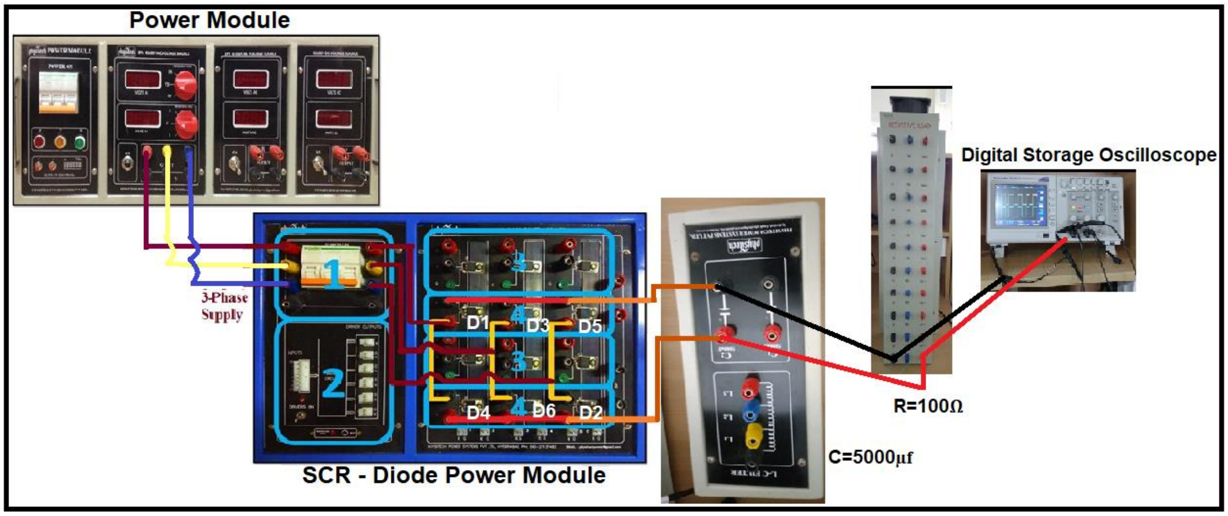
Procedure:

1. Connect the circuit as shown in above figure (with R load (**R=100 ohms, C = 5000µF**),
2. Switch ON the MCB of 3Ø supply on the Left hand side of your Experimental Table.
3. Switch ON the MCB on the POWER MODULE kit.
4. Switch ON the MCB on the SCR-Diode Power module and slowly increase the Voltage to reach up to 35.35 V in RMS using **+** symbol Push Button in the Power Module kit.

   Note: The Voltage Adjustment Controls are a pair of push buttons to finely adjust the voltage to required value.

5. Connect CRO probes across the **R** load to measure the output voltage.
6. Observe the Output voltage waveforms and the FFT plot in the CRO.

2.b) Hardware Implementation full wave Three phase diode Rectifier with C Filter



Procedure:

1. Connect the circuit as shown in above figure (with R load (**R=100 ohms, C = 5000µF**),
2. Switch ON the MCB of 3Ø supply on the Left hand side of your Experimental Table.
3. Switch ON the MCB on the POWER MODULE kit.
4. Switch ON the MCB on the SCR-Diode Power module and slowly increase the Voltage to reach up to **61.2 V in RMS** using **+** symbol Push Button in the Power Module kit.

   Note: The Voltage Adjustment Controls are a pair of push buttons to finely adjust the voltage to required value.
5. Connect CRO probes across the **R** load to measure the output voltage.
6. Observe the Output voltage waveforms and the FFT plot in the CRO.

Conclusion: Obtain the results as per "Exp4_Part B.doc" file.