Power Electronics Lab (EE39006)

Department of Electrical Engineering, IIT Kharagpur

Session: Autumn, 2021-22

Title: STUDY OF A THREE PHASE AC TO DC CONTROLLED CONVERTER.

Part A: Develop a cosine triggering circuit to generate the gate pulses for a thyristor-based three-phase full-controlled converter. The AC grid is balanced, and has a line voltage of 400 V (50 Hz). Synchronizing transformer connection: $Yy(n)\,0$. Choose the turns ratio of the synchronizing transformer such that the peak phase voltage on the LV side is 5 V. Neglect any non-idealities of the transformer.

Part B: Simulate an ideal three-phase full-controlled converter supplying a constant current load of 5 kW. Neglect any source inductance.

1. Calculate the firing angle α such that the average DC side voltage is equal to 350 V.
2. Observe the AC side currents and the load voltage. Plot these variables (along with the AC grid voltage) for 1 complete fundamental cycle period.
3. Now, add a source inductance of value 5 mH for all the three phases. Repeat **Part B**(2), for the same firing angle α as obtained previously.

Part C: Simulate an ideal three-phase semi-controlled converter with an RL load. Consider $L = 50$ mH. Neglect any source inductance.

1. It is desired to obtain an average output voltage of 50% of the maximum average output voltage. Calculate the required firing angle α. Calculate R, such that the DC load consumes a power of 2.5 kW.
2. Observe the AC side currents and the load voltage. Plot these variables (along with the AC grid voltage) for 1 complete fundamental cycle period.
3. Again, observe the AC side currents and the load voltage for different values of α.

Part D: Compare the performance of a three-phase full-controlled rectifier, with a three-phase semi-controlled rectifier. Consider $\alpha = \pi / 9$, and a constant load current of 7.5 A. Fill up the following (neglect any effect of source inductance)

Parameter	Full-controlled Converter	Semi-controlled Converter
AC side currents (RMS)		
Fundamental component of the AC side currents (RMS)		
THD (in %) of the AC side currents		
Input power factor		
Fundamental active power (W)		
Fundamental reactive power (VAr)		

Discussion Questions

1. Consider an ideal three-phase full-controlled converter with an R load. Obtain the expression of the average output voltage (for $\alpha \in [0, \pi/2]$).

2. Refer to **Part B**(5), what is the commutation overlap angle μ? What is the average output DC voltage?

3. Refer to **Part D**, compare the frequency components in the AC side currents for the two converters.

4. For the full-controlled converter in **Part B**, consider a regenerative load, with the same load current as in **Part B**(1). Calculate the firing angle so that the power absorbed by the AC grid is 4 kW (neglect any effect of source inductance).