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 linear 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 440 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 with a constant load current of 10 A. Neglect any source inductance.

1. Calculate the firing angle α such that the average DC side voltage is equal to 380 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. What is the maximum reverse voltage across the thyristors?
4. Observe the AC side currents and the load voltage for different values of α.
5. 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 $L = 100$ mH. Neglect any source inductance.

1. Set the firing angle $\alpha = \pi\,/\,4$. Calculate R, such that the load current is 10 A.
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 $\alpha = \pi / 6$, and a constant load current of 10 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. Refer to **Part B**(1), calculate the
   - Distortion factor.
   - Fundamental displacement factor.
   - Input power factor.
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 distortion factor of the two converters. Why is the distortion factor less in case of semi-controlled rectifier?