Electrical Machines Laboratory

Department of Electrical Engineering, IIT Kharagpur

Session: Spring, 2021-22

Experiment #3

Synchronous Machine Experiments

Instruction Set

Machine Parameters and Ratings

DC Machine	Synchronous Machine
Power = 20 kW	Power = 20 kVA
Speed = 1500 RPM	Frequency = 50 Hz, Pole pairs = 2
Armature voltage, current = 300 V, 65 A	Armature voltage, current = 400 V (L-L rms), 30 A
Field voltage, current = 300 V, 5.7 A	Field voltage = 400 V

1. **Synchronous Machine at No-Load**

   - Mechanically couple the Synchronous Machine with the DC Machine.
   - Perform No-Load test on the given Synchronous Machine using the provided simulation file. Gradually, change the excitation voltage in steps till rated.

2. **Loading of Grid-connected Synchronous Machine**

   - Synchronize the Synchronous Machine with the three-phase grid.
   - Operate the synchronous machine at various loading conditions for generating as well as motoring mode and take the following readings

   (a) Tabulate and plot V-curve ($I_{R(rms)}$ vs E_f) for 15 kW load, 5 kW load and No-Load in the same graph.

Load Power	**Armature Voltage, V_{L-L}**	**Excitation Voltage, E_f**
15 kW		
5 kW		
No-Load		

(b) Tabulate and plot inverted V-curve (p.f. vs E_f) for 10 kW load.

Load Power	**Power factor**	**Excitation Voltage, E_f**
10 kW		

(c) Note the load angle of the synchronous machine when you apply load of 2.5 kW and 7.5 kW in motoring mode as well as generating mode.

Mode	**Load Power**	**Load angle δ (in deg)**
Generating	7.5 kW	
	2.5 kW	
Motoring	7.5 kW	
	2.5 kW	

Discussion Questions

- Why the frequency of incoming alternator is kept slightly higher than grid frequency?
- State the effect of wrong synchronization.
- For the given experiment set up how can you make the synchronous machine become a generator feeding power to the bus?
- If the two 400 V machines are to be synchronized by dark lamp method what will be the voltage rating of the bulb?