**Lab #3 – Synchronous Motor**

**ECE 325 - Electric Energy System Components**

**Instructor: Dr. Kai Sun**

**Lab TA’s: Denis Osipov and Wenyun Ju**

**Objective:**

The objective of this lab is to examine the terminal characteristics of a synchronous motor under load and no-load conditions.

**Pre-lab:**

1. What is an important feature of synchronous motors?
2. Draw an equivalent circuit model for a synchronous motor. Show *Ef*, *Xs*, *Ra*, *Ia*, *Vt*, *If*, and the field winding.
3. Describe the open-circuit test. What is measured? What is varied? Sketch the circuit.
4. Describe the short-circuit test. What is measured? What is varied? Sketch the circuit.
5. Sketch an open-circuit characteristic and a short-circuit characteristic. Show *Ia* (rated), *Vt*(rated), and a modified are gap line.

**Lab Exercise:**

**Part A**

The open-circuit and short-circuit tests will be performed to determine values for *Xs*and *K*, using the synchronous machine as a generator.

Procedure:

1. Connect the DC machine as a self excited shunt generator as shown in Lab #3 Part A wiring diagram.
2. Couple the DC machine to the synchronous machine.
3. Set the 0-125 VDC knob to zero.
4. Set the 0-150 VDC knob to zero.
5. Set the synchronous machine to ‘IND START’.
6. Bring the DC machine terminal voltage up to 125 V, and adjust the field rheostat to obtain a speed of 1800 RPM.
7. Set the synchronous machine to ‘SYNCH RUN’.
8. Perform the open-circuit test: With the synchronous machine’s terminals open, measure the voltage across the winding (*Voc*) as field current (*If*) in increased. Increase the field current by increasing the DC voltage across the field winding. Vary *If* from 0 to 1A in increments of 0.1A.
9. Set *If* to zero.
10. Perform the short-circuit test: Short the phase windings of the synchronous machine and put an ammeter in series with the shorted windings. Measure the average winding current (*Isc*) as *If* in increased. Vary *If* from 0 to 1A in increments of 0.1A.

Calculation:

1. At *Vt*=*VOC*=120V, calculate *Xs* and *K*. (*Xs*= *VOC* */ Isc* and *K*= *VOC* */ If*)
2. Plot *|Ia|* vs. *If*. (*|Ia| =|( Vt -K\* If)/Xs|*)

**Part B**

The armature current will be measured as field current is varied under load and no load conditions.

No Load Procedure:

1. Connect the system as shown in Lab #3 Part B wiring diagram, but do not couple the synchronous machine to the DC machine.
2. Set the synchronous machine to ‘IND START’.
3. Turn the 0-150 VDC knob to position ‘0.5’.
4. Turn on main power.
5. Set the synchronous machine to ‘SYNCH RUN’. The motor speed should be at 1800 RPM.
6. Measure *Ia* and *If* as *If*is varied up to 1A in increments of 0.1A.

Load Procedure:

1. Turn off main power.
2. Mechanically couple the synchronous machine to the DC machine.
3. Set the first eight switches of the resistance load to ‘ON’.
4. Set the synchronous machine to ‘IND START’.
5. Turn on main power.
6. Turn the 0-150 VDC knob to position ‘2.0’.
7. Turn the 0-125 VDC knob to position ‘8’.
8. Set the synchronous machine to ‘SYNCH RUN’. The motor speed should be 1800 RPM.
9. Measure *Ia* and *If*  as *If* is varied up to 1A in increments of 0.1A.

Calculation:

1. Plot *Ia* vs. *If* for load and no load conditions and compare with calculated graph.
2. Is there a best field current at which the synchronous machine should be operated?

**Lab #3 Part A Wiring Diagram**



**Lab #3 Part B Wiring Diagram**