Synchronous Machine Tests and Synchronization

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1 INTRODUCTION

The objective of this lab was to get exposed to synchronous motors and see how to work with them. We did a few tests first to get parameters of the motor then proceeded to synchronize it with the grid using the light bulb method. This lab was quick and not tedious to complete, however still gave a good understanding of synchronous motors.

All data/measurements taken are provided in the appendix at the bottom of the document.

2 RESULTS

2.1 *Open/Short Circuit Tests*

The first part of this lab was to characterize the motor. We completed tests similar to the induction motor lab to get parameters of this motor.

Table 1: Open Circuit Data

Rf2 (Ohms)	Field Current (A)	Armature Current (A)	Va (V)
infinity	0	0	.82
500	.308	0	44.9
250	.530	0	75.6
166	.689	0	96.3
125	.814	0	111.4
100	.917	0	122.4
83.3	.988	0	129.4
71.43	1.05	0	134.9
62.5	1.10	0	138.9
55.56	1.15	0	142.04
50	1.20	0	144.6

Table 2: Short Circuit Data

Rf2 (Ohms)	Field Current (A)	Armature Current (A)	Va (V)
infinity	0	.318	.13
500	.308	2.37	4.02
250	.529	4.07	6.99

Fig.1 OCC and SCC Data

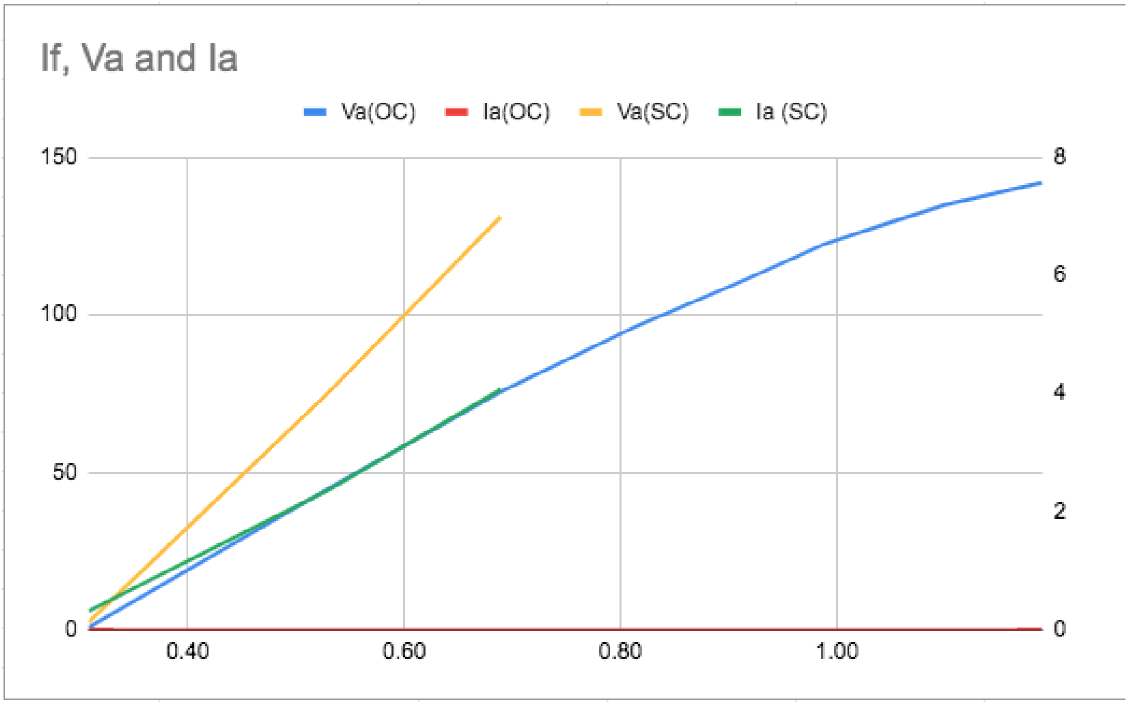
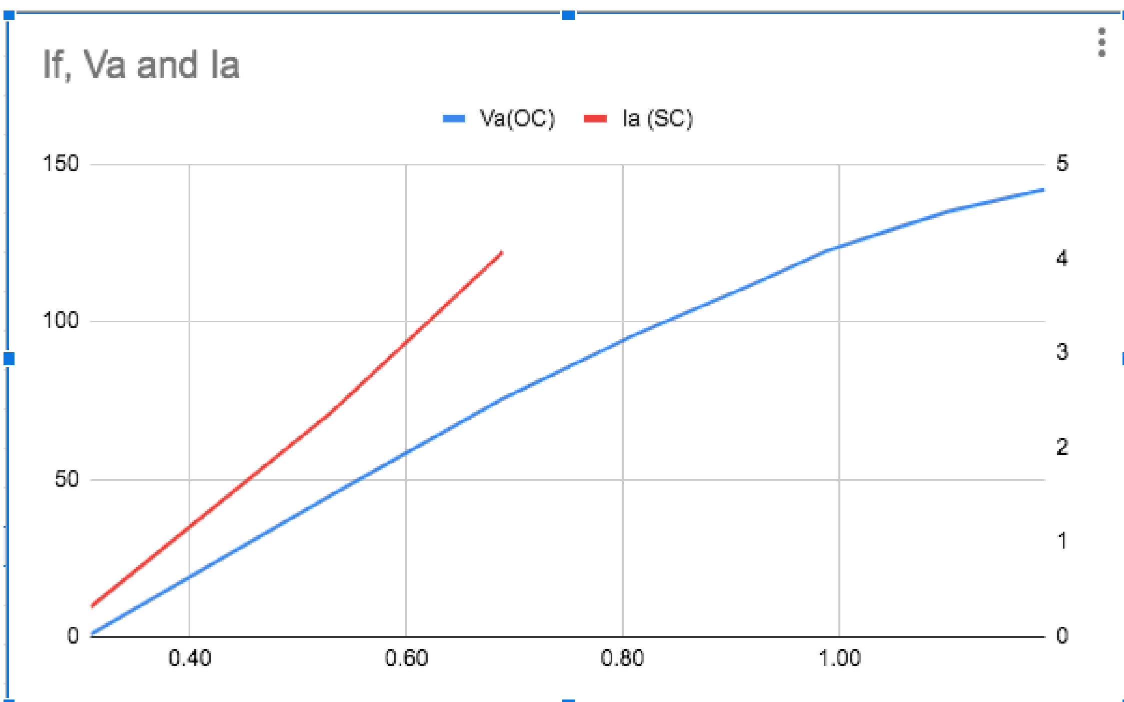


Fig.2 OCC and SCC Data (only Ia SC and Va OC)



With this data we can calculate K_f and x_s (saturated and unsaturated).

$$E_a = K_f \cdot \omega \cdot I_f$$ **Equation 1.**

It is evident that K_f is just he slope of Va vs If.

Thus the **unsaturated K_f = 138.58** and **saturated K_f = 51.2**

Similarly we can calculate x_s with the following equation:

$$x_s = \frac{V_a}{I_a} \quad \textbf{Equation 2.}$$

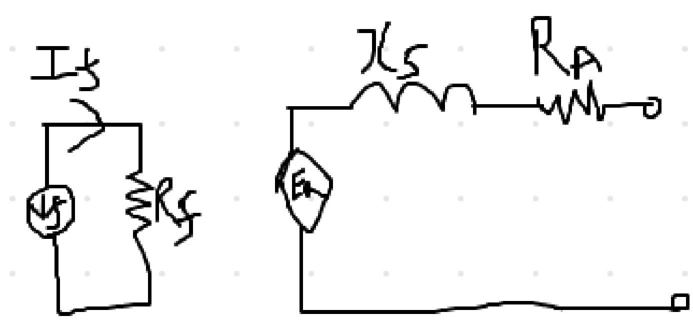
So **unsaturated x_s = 0.409 ohms** and **saturated x_s = 1.72 ohms**

2.2 *Motor Synchronization*

In this part of the lab we used lights to synchronize the motor to the wall outlets. We did so by adding the lights between the 3 phases of our power supply and 3 phases of the motor. When the lights were completely off it shows that the voltage difference between the two sides is 0 and the motor is synchronized with the supply. We adjusted the motors speed using **Torque modulation** and once the lights were cycling on and off slowly we knew we had the right timing. We were basically adjusting I_f to change motor speed until it was easy for us to see synchronization.

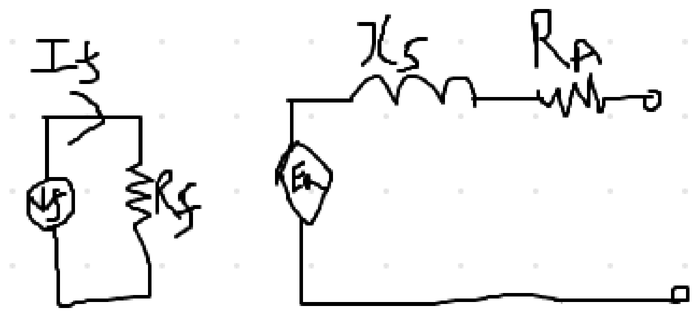
2.3 *Experimental Diagram*

Fig.3 Unsaturated Circuit Diagram



R_f=128.3, X_s=.409, R_A = .72

Fig.4 Saturated Circuit Diagram



R_f=128.3, X_s=1.72, R_A = .72

3 CONCLUSION

This lab gave us a good look into synchronous machines and how they are operated to work like we want. The experiments we did showed the benefits of using synchronous motors and how they are more efficient. Further we also inspected torque vs current effect and how higher rotor resistance affected Voltage and field current. The OCC and SCC allowed us to get values to draw the equivalent circuit, similar to an induction motor.

4 REFERENCES

[1] P.W. Sauer, P.T. Krein, P.L. Chapman, *ECE 431 Electric Machinery Course Guide and Laboratory Information*, University of Illinois at Urbana-Champaign, 2005.

5 APPENDIX

Raw Data: