

Introduction

In this exercise you will investigate the basic characteristics of a three-phase induction motor.

Procedure

- Record the “motor” ratings of the 3Φ Squirrel-Cage Induction Machine (EMS 8221), and determine the **rated torque** for the machine in *inch-pounds*.

$$V_{\text{rated}} = \text{_____ V} \quad I_{\text{rated}} = \text{_____ A} \quad P_{\text{rated}} = \text{_____ hp} \quad n_{\text{rated}} = \text{_____ rpm}$$

$$T_{\text{rated}} = \text{_____ lb}\cdot\text{in}$$

- Perform a **Load Test** on the 3Φ Squirrel-Cage Induction Machine operating as a motor:
 Adjust the variable 3Φ voltage source to supply and maintain rated voltage to the stator windings. Vary the load torque provided by the dynamometer from 0 to 12 *lb·in* in 3 *lb·in* increments. Record the rotor speed, the line current magnitudes, and the per-phase real power supplied to the motor for each load-torque step and the mechanical shaft power.

I _a (amps)	I _b (amps)	I _c (amps)	P _a (watts)	P _b (watts)	P _c (watts)	Torque (lb·in)	SPEED (rpm)	P _m (watts)
						0		
						3		
						6		
						9		
						12		

Table 6.1 – Induction Motor Load Test Data at 100% Rated Voltage

- Repeat the **load test** of the induction motor but this time with the applied voltage magnitude equal to **80%** of the machine’s rated operating voltage. (*Do not go above 110% of rated current*)

I _a (amps)	I _b (amps)	I _c (amps)	P _a (watts)	P _b (watts)	P _c (watts)	Torque (lb·in)	SPEED (rpm)	P _m (watts)
						0		
						3		
						6		
						9		

Table 6.2 – Induction Motor Load Test Data at 80% Rated Voltage

- Perform a **Locked-Rotor Test** on the Induction Machine with rated voltage supplied to the stator. Record the magnitude of the line currents and the per-phase real power supplied to the machine.

Locked Rotor Test	I _a (amps)	I _b (amps)	I _c (amps)	P _a (watts)	P _b (watts)	P _c (watts)	SPEED (rpm)

Table 6.3 – “Locked-Rotor” Test Data at 100% Rated Voltage

5. Perform a **No-Load Test** on the Induction Machine with rated voltage supplied to the stator. Record the magnitude of the line currents and the per-phase real power supplied to the machine.

No Load Test	I _a (amps)	I _b (amps)	I _c (amps)	P _a (watts)	P _b (watts)	P _c (watts)	SPEED (rpm)

Table 6.4 – “No-Load” Test Data at 100% Rated Voltage

6. Measure and record the **DC resistance** of each stator winding. Note – although a DC to AC resistance scaling factor of 1.2 is often used to account for skin effect in large machines, during this experiment you may use the DC resistance value for any calculations due to the small size of the test machine.

$$R_a = \underline{\hspace{2cm}} \Omega \quad R_b = \underline{\hspace{2cm}} \Omega \quad R_c = \underline{\hspace{2cm}} \Omega$$

Report Guide

LOAD TESTS (Procedure Steps 2-3)

- Plot **load torque vs. rotor speed** at both 100% and 80% rated voltage on a single graph.
- Calculate the **efficiency of the machine** as the load is varied from 0 to 12 lb-in directly from the lab data for both 100% and 80% rated voltage operation. Add a column to the right of P_m in both of your “Load Data” tables and display the calculated efficiency results.
- Plot **efficiency vs. rotor speed** at both 100% and 80% rated voltage on a single graph.

MODEL PARAMETER TESTS (Procedure Steps 4-6)

- Utilizing the results of the Locked-Rotor, No-Load, and Stator Resistance tests, **determine the per-phase model parameters** (R_{fe}, X_m, R_{eq}, X_{eq}, and R_r) for the Induction Machine.
- Using the calculated model parameters for the Induction Machine, **calculate the theoretical efficiency** of the motor under full-load conditions. For this calculation, assume rated stator voltage (120 V_{phase}) and use the motor **speed** that you measured during lab **with a 9 lb-in load** applied to the motor while operating at 100% rated voltage (from Step 2) to determine the value of slip needed to complete your circuit model analysis.
- Compare** the full-load efficiency of the motor calculated from the circuit model to the efficiency value determined directly from the lab data while operating at 100% rated voltage and 9 lb-in load.