Introduction

In this exercise you will investigate the operational characteristics of a 3Φ Squirrel-Cage Induction Motor while supplied at 100% rated voltage under no-load and loaded conditions.

Procedure

RATINGS

1. Record the **ratings** of the 3Φ Squirrel-Cage Induction Motor and determine the **rated torque** for the motor in units of **inch·pounds** and **Newton·meters**.

   Notes: $T_{(ft\cdot lb)} = \frac{P_{(hp)}\cdot 5252}{n_{(rpm)}}$ $\quad 1\ lb\cdot in = \frac{1}{12}\ lb\cdot ft$ $\quad 1\ N\cdot m = 0.7375\ lb\cdot ft$

INITIAL SETUP (Your instructor may have already completed **steps 2 – 7** for you.)

2. Confirm that the main **Lab Volt power supply** is switched **OFF**, and rotate the large variable-voltage control knob on the supply to its 0-volt (CCW-most) position.

3. Connect a **belt** between the pulleys of the **Induction Motor** and the **dynamometer**, and then position the belt between the tensioners attached to the Induction Motor's frame.

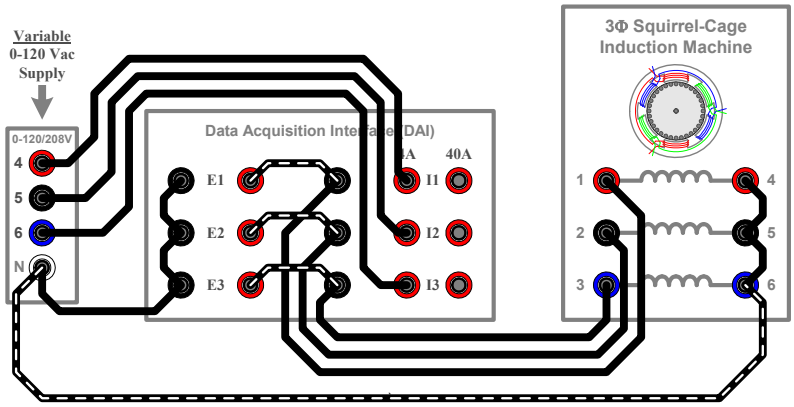
4. Connect a **grey power cable** from the **24 V_{AC} supply** (that is present on the main Lab Volt power supply) to the **Data Acquisition Interface** and switch **ON** the 24 V_{AC} supply.

5. Connect a **USB cable** between the **Data Acquisition Interface** and the **desktop computer**. Note – the cable must be plugged into a specific port on the desktop computer. If the cable is not already connected, ask the instructor for assistance identifying the correct USB port.

6. Plug the **dynamometer** into an available **120 V_{AC} receptacle** and switch **ON** the dynamometer.

7. Using three specialty interface cables (red, yellow, and white), connect the **Torque**, **Speed**, and **Ground** outputs of the **dynamometer** to the associated inputs of the **Data Acquisition Interface**.

8. Wire the **Induction Motor** such that it is supplied through the Data Acquisition Interface by the **variable 3Φ, 0-208V source** (terminals 4-5-6) such that the Data Acquisition System is able to measure all of the **phase-voltages** (**E_1, E_2, E_3**) and **line-currents** (**I_1, I_2, I_3**) being supplied to the motor. (See the figure below for the proper wire connections.)



9. Make sure that the **Mode** switch on the Dynamometer is set to "**DYNAMOMETER**" and press the "**Start/Stop**" button to cycle through the different operational modes on the dynamometer until "**Neg. CT Prime Mover / Brake**" is shown in the Status field of the LCD display.

10. Rotate the Manual knob in the Load Control area of the dynamometer to its "Minimum" (CCW-most) position in order to set the load torque provided by the dynamometer to **0 N·m**.

11. Run the **LVDAC-EMS software** (icon available on the desktop). Choose "**Connected Mode**" in the pop-up window that appears after a short delay, and click "**OK**" in the "LVDAC-EMS Start-Up" window that appears next to confirm $120V_{AC}$ – 60Hz operation of the Data Acquisition Interface.

12. Open the **Digital Meters** window within the LVDAC-EMS software and configure the meters to display all of the **phase-voltages** (**E_1, E_2, E_3**) and **line-currents** (**I_1, I_2, I_3**) being supplied to the motor, along with the **real power** (**P_1, P_2, P_3**) supplied to each phase of the Induction Motor by the 3Φ source, and the **torque** (**T**), **speed** (**n**), and **mechanical power** (**P_m**) associated with the dynamometer as the mechanical load for the induction motor.

13. Have your instructor verify your setup before continuing on to the next step.

RATED VOLTAGE OPERATION

14. Switch **ON** the main Lab-Volt supply and **raise** the variable 3Φ **voltage** to **$120V_{phase}$** ($208V_{line}$).

Under no-load operation, an induction motor should rotate at its **synchronous speed**, **n_s**, where:

$$n_s = \frac{120 \cdot f_{elec}}{\#\, poles}$$

Since rated speed of an induction motor is less than but typically within 5% of its synchronous speed, based on the motor's rated speed (1670) at a frequency of 60Hz, the only reasonable value for the number of poles for the motor is four (4).

Due to the friction provided by the tensioners through which the belt is fed, which acts like a mechanical load to the motor, the motor will not quite reach its synchronous speed.

Press the "**Start/Stop**" button on the dynamometer so the "Status" field displays "**STARTED**".

With the dynamometer set to **zero** (**0**) torque, **measure** the "no-load" **rotational speed** of the motor.

15. Perform a **Load Test** on the 3Φ Squirrel-Cage Induction Motor while **maintaining rated voltage**:

Adjust the load torque on the dynamometer from **0→1.36 N·m** in increments of **0.34 N·m (3 in·lb)** and record the magnitude of the **line-currents** (**I_1, I_2, I_3**) and the **real powers** (**P_1, P_2, P_3**) supplied to the motor, the rotational **speed** (**n**) of the motor, and the **mechanical power** (**P_m**) supplied to the dynamometer at each load-torque value. Record the values in Table 6.1.

16. Once the measurements are complete, lower the load-torque on the dynamometer to **0 N·m** and press the "**Start/Stop**" button so the "Status" field displays "**STOPPED**".

17. Lower the **supply** voltage to **0 volts** and switch **OFF** the Lab Volt supply.

18. Have your instructor check your measurements BEFORE disassembling your circuit.

ECET 3500 Lab 6 Data **Name:**_____

Date _____ **Lab Section** _____

RATINGS – 3Φ Squirrel-Cage Induction Machine Ratings:

V_{rated} = _____**V** **I_{rated} =** _____**A** **P_{rated} =** _____**hp** **n_{rated} =** _____**rpm**

T_{rated} = _____ **lb·in** **T_{rated} =** _____ **N·m**

RATED VOLTAGE OPERATION

Synchronous Speed = _____**rpm**

No-Load Speed with belt connected = _____**rpm**

Torque (N-m)	I_a (amps)	I_b (amps)	I_c (amps)	P_1 (watts)	P_2 (watts)	P_3 (watts)	SPEED (rpm)	P_m (watts)
0								
0.34								
0.68								
1.02								
1.36								

Table 6.1 – Operational Characteristics at 100% of Rated Voltage

Report Guide

For this experiment, you are required to submit an electronically-generated **lab report** in D2L that contains no hand-written or hand-drawn information, in the **same format** as that specified in Lab 2 earlier this semester, which includes a simple procedural statement along with a data table for any measurements performed in the lab. Additionally, the following should be included within your report:

a) Plot load torque vs. rotor speed.

b) Calculate the efficiency of the machine as the load is varied from 0 to 1.36 N·m directly from the lab data. Add a column titled "Efficiency" to the right of P_m in your data table and display the calculated efficiency at each load-torque value.

$$efficiency = \frac{P_{out}}{P_{in}} \cdot 100\% = \frac{P_m}{P_a + P_b + P_c} \cdot 100\%$$

c) Plot efficiency vs. % of rated output power for the Induction Motor at each of the load-torque settings.

$$\%rated\ output\ power = \frac{P_m}{P_{rated}} \cdot 100\%$$