

MACHINES LABORATORY - 5

INDUCTION MOTORS

In this experiment you would test a three phase induction motor. It has a squirrel cage rotor. (Conductors placed along the length of the rotor are shorted at either end). The motor runs a DC generator (Dynamometer) coupled to it by a belt. The induction motor is loaded by loading the generator (by dissipating the power generated in a resistance located in the dynamometer module). You would also determine the equivalent circuit of the induction motor.

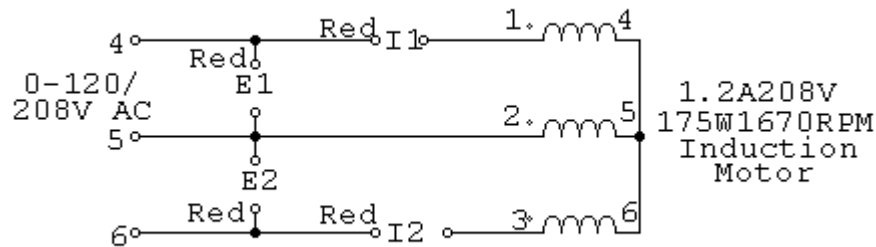
PROCEDURE:

PART A: LOAD TEST.

Step 1: Set the voltage control to zero. Mechanically couple the dynamometer to the three-phase induction motor by the belt.

Step 2: Ensure that the low power terminal on the data acquisition interface is connected to the low power input of the **PRIME MOVER / DYNAMOMETER** module. The Torque Output, Speed Output and Ground terminals of the module are respectively connected to T, N and Ground terminals of the data acquisition interface (use the three thin connectors)

Step 3: Set the **MODE** switch (located between the **PRIME MOVER INPUT BOX** and the **DYNAMOMETER LOAD CONTROL BOX** to Dynamometer. Set the **MODE** switch in the dynamometer load control box to **Man(ual)**. Set the potentiometer marked **MANUAL** (located on the left in the dynamometer load control panel) to the minimum. It controls the load power of the dynamometer. In the following text, it is referred to as **POWER CONTROL KNOB**.



Step 4: Connect the circuit shown.

Step 5: Click on Setup Base Meters. Check in boxes marked **Compensated Torque, Torque and Speed**. Select digital mode of operation. Click on OK. Click on Setup Power meters and check in the box **Mechanical Power**. Select digital mode. Click on OK. Click on Setup Programmable meters. Set meter-A on PQS1 + PQS2 to measure total input power. Set meter-B on $\cos \phi$ to measure power factor. Set meter-C to measure $P_m / (P_1 + P_2)$ to measure efficiency of the induction motor. Click on OK. Turn off the meter E2. The display appears black. You can turn the display off by clicking on the box marked E2 (top right of the meter). Likewise turn off I2, E3, I3, and P3. We need to do so, since the data table can not hold all the variables. Turn on the programmable meters.

Step 6: Turn the voltage control clockwise. The motor starts to rotate. Set the control at 100. The display panel in the Prime Mover / Dynamometer module displays either the speed or the torque based on the position of the toggle switch located on the left of the display. If the speed indicated is negative, reverse the direction of rotation of the motor. You can do it by interchanging the inputs 4 and 5 (Do so after setting the voltage control to zero). The torque displayed is the torque on the dc machine (uncompensated torque). The torque measured by the meter is the torque on the motor (compensated torque). The compensated torque is the sum of uncompensated torque and the torque on the motor when the power control knob is set at the minimum i.e., the uncompensated torque is zero.

Step 7: Enter the data in the table by clicking on “Record Data”. Turn the power control knob clockwise to increase the load. Record the data. **The current I_1 should not be more than 1.2 A.** Record at least six data sets in the range 0 to 1.2 A of I_1 . Set the power control knob to the minimum and voltage control knob to zero.

Step 8: Obtain the plot Speed Vs Torque.

PART B: VOLTAGE-SPEED CHARACTERISTIC FOR A GIVEN LOAD.

Step 1: Set the Voltage Control at 100. Turn the power control knob till I_1 is about 1A. Record the data.

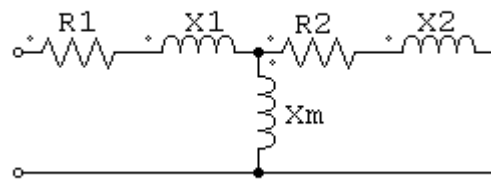
Step 2: Set the voltage control at 90. Record data.

Step 3: Repeat step 2 for voltage control settings at 80, 70 and 60. Set the power and the voltage controls at the minimum values.

Step 4: Plot Speed Vs Voltage.

PART C: EQUIVALENT CIRCUIT.

The approximate equivalent circuit of an induction motor is shown below:



Short Circuit Test:

Step 1: Set the voltage control at about 30. The motor should not rotate (If it does, set the voltage control at a lower value. Record E_1 , I_1 , P_1+P_2 (Programmable meter A) and power factor $\cos \phi$ (Programmable meter B). The current in X_m is taken to be zero. The phase impedance Z is $E_1 / \{1.732\} \{I_1\}$. Then $\{R_1+R_2\} = Z \{\cos \phi\}$ and $\{X_1+X_2\} = Z \{\sin \phi\}$. We assume that X_1 is equal to X_2 .

Step 2: Set the voltage control to zero.

Open Circuit Test:

Step 1: Decouple the induction motor from the dynamometer. (Remove the belt)

Step 2: Set the voltage control at 100.

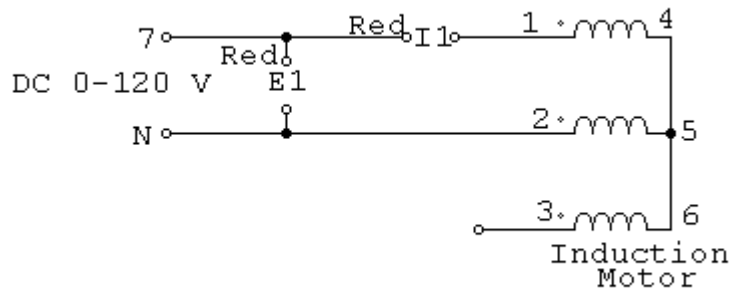
Step 3: Measure E_1 , I_1 and P_1+P_2 . Set the voltage control at zero. Then $\{X_1+X_m\} = E_1 / I_1$.
The friction and windage losses are equal to P_1+P_2 . The core losses are neglected.

Step 4: Remove one input to the motor i.e., pull the wire connected to terminal 2 of the motor. Note that the motor continues to rotate. It runs as a **single phase** motor. Note that I_1 is more than the value measured in Step 3 above.

Step 5: Put the belt back.

D.C. Resistance:

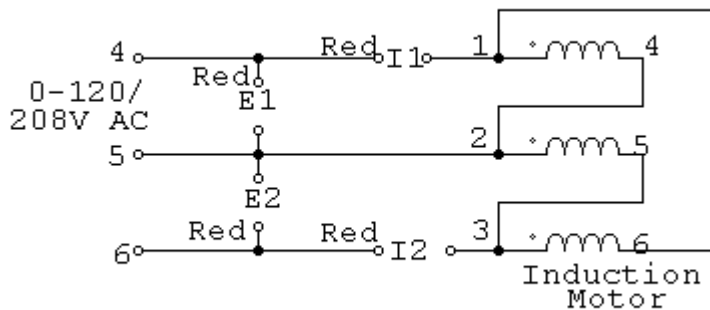
Step 1: Connect the circuit shown. Set the voltage control to about 20. Measure E_1 and I_1 . Then R_1 is equal to $\{0.5\}E_1/I_1$.



PART D: Delta Connected Induction Motor: Load Test

Step 1: Connect the circuit shown.

Step 2: Repeat Steps 6 to 8 of Part A. The voltage control should not be set at a value greater than 60. **The line voltage (E_1) should not be more than 120 V. I_1 should not exceed 2A.**



DATA: PART A

E1	I1	P1	P2	T	N	Pm	A-1	A-2	A-3

PART B

E1	I1	P1	P2	T	N	Pm	A-1	A-2	A-3

PART C

	E1	I1	P1+P2	Power Factor
Short Circuit Test				
Open Circuit Test				
DC Test				

Calculated Values in Ohms:

R1: _____ R2: _____ $X1 = X2 =$ _____ $Xm =$ _____

PART D

E1	I1	P1	P2	T	N	Pm	A-1	A-2	A-3