EXPERIMENT NO. 5

Objective

To perform no load, blocked rotor and load tests on a 3-phase squirrel cage induction motor and draw its equivalent circuit referred to the stator and calculate the efficiency of the motor. Also obtain the performance characteristics of the motor theoretically from the equivalent circuit parameters and compare it with the experimentally obtained results.

Laboratory Work

No load and blocked rotor tests:

1. Write down the specifications motor and dc generator.

2. Draw the circuit diagram as shown in Fig.5.1A for no-load test and 5.1B for blocked-Rotor test showing the proper ranges of the meters according to specification of the machine for both no-load and blocked rotor test and get it approved by lab instructor.

3. Make the connections as shown by the dotted lines and get it checked by the lab instructor for both no-load and blocked rotor test separately.

4. Conduct a no-load test at the rated voltage and note down the line current and input power of the motor [See Fig. 5.1]. Use the appropriate ranges of meters. Start with variac in zero position.

5. Conduct a blocked rotor test by blocking the rotor from rotating. Use the same circuit as in Fig. 5.1, with meters changed to appropriate ones. Before switching on, make sure that the variac is in zero position and increase voltage slowly up to a value when the rated current of induction motor will flow. Note down the reading of all the meters.

6. Switch off the three phase main supply and bring back the variac to zero position.

7. Measure the d.c. resistance of the stator.

Load test:

1. This test is to be conducted with the motor coupled to the D.C shunt generator. Make the connections as shown in Fig. 5.2. (Note: Switch On the supply of cooling fan of DC generator before starting the load test.)

2. Apply the rated voltage to the induction motor and run the generator under no-load condition with its field resistance at maximum position. Adjust the field resistance so that generator output voltage attains 180V and keep it constant.

3. Note down the readings of input power, input current, output voltage, output current and speed of the induction motor.

4. Now increase the load i.e. current of dc generator by switching on the switches of load box step by step, (while maintaining the terminal voltage of DC shunt generator at 180V by varying the field rheostat). **Take the readings of all the meters at 50%, 60%, 70%, 80% and 100% of rated current** the 3-phase induction motor. **(Note: At 100% rated current of induction motor, the terminal voltage of DC Shunt Generator may be required to set less than 180V because constant step loading.)**

5. Repeat the same experiment for reduced input voltage of induction motor **(90% and 70% of rated value).** Tabulate your readings as follows.

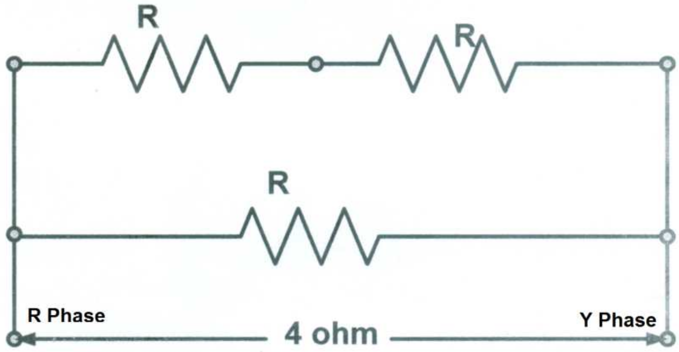
Load test (readings)

Sl. No	Motor Voltage (Stator, V)	Motor Current (Stator, Amp)	P_1 (W)	P_2 (W)	N (rpm)	DC Generator Voltage (V)	DC Generator Current (Amp)

Calculation of Equivalent Circuit Parameters:

The one-phase equivalent circuit of a three phase induction motor is shown in Figure 5.3. (R_1+ jX_1) is the stator winding impedance per phase, (R_2'+ jX_2') is the rotor winding impedance per phase referred to the stator side, (G_c+ jB_m) is the magnetizing circuit admittance per phase, and 's' is the rotor slip of the motor, which, generally varies between 1-5% under normal running condition. The parameters of the equivalent circuit can be determined from the results of the blocked rotor and the no-load tests, similar to the case of single phase motor in the experiment-4, and briefly given as following.

Calculation of the DC Resistance of Stator winding of a delta connected three-phase Induction Motor:



In the above figure the resistance between the R phase and Y phase is measured using the multimeter, the measured value of resistance between the R phase and Y phase is **4 ohm**, let us consider the winding of the 3 phase induction motor are identical and having resistance of each winding is R **Ω**.

So per phase resistance of stator winding is:

$$R_{RY} = (R+R) \parallel R$$

$$\mathbf{4} = 2R \times \frac{\boldsymbol{R}}{\boldsymbol{3R}}$$

$$\boldsymbol{R_{dc} = 6\Omega = R_{1dc}}$$

1. From the measured value of DC resistance of the stator winding per phase (R_{1dc}), compute R_1 = k. (R_{1dc}), where k accounts for skin effect and varies between 1.1 to 1.3.

2. Under block rotor test, the applied voltage is quite small and slip s=1. The approximate equivalent circuit, neglecting the magnetizing branch is shown in Figure 5.5. Using the ammeter, voltmeter and wattmeter reading per phase, the value of R_2' and ($X_1 + X_2'$) can be computed from Fig. 5.5. It is assumed that $X_1 = X_2'$.

3. Under no load condition, the full rated voltage is applied and slip is very small, close to zero. The approximate equivalent circuit under no load can be drawn, by shifting magnetizing branch across the supply, as shown in Figure 5.4. From this figure and using the ammeter, voltmeter and wattmeter readings, the magnetizing branch parameters G_c and B_m can be computed.

Report

1. The report should include the equivalent circuit of the motor with all parameter values indicated and the performance characteristics mentioned in the section "Objective", derived from the equivalent circuit. While calculating the efficiency of the induction motor, assume the efficiency of the DC generator as 90%.

2. Plot the torque–speed characteristics of the motor on a graph paper for the different input voltages, determined through theoretical calculations.

3. On the same graph plot the torque–speed characteristics, obtained experimentally

Circuit for No-Load Test:

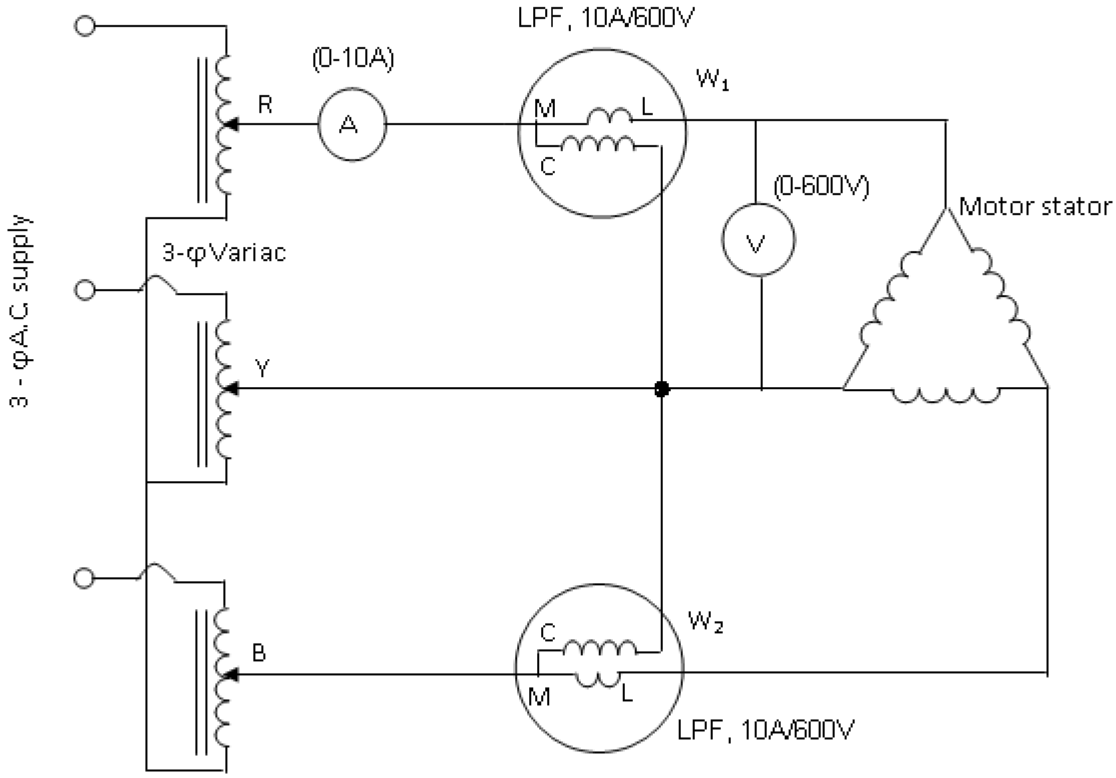


FIG.5.1A. Connections for No-Load Test

Note: The Low Power Factor Wattmeter required the additional single phase ac supply for working. The connection cord is provided for the purpose.

Circuit for Blocked-Rotor Test:

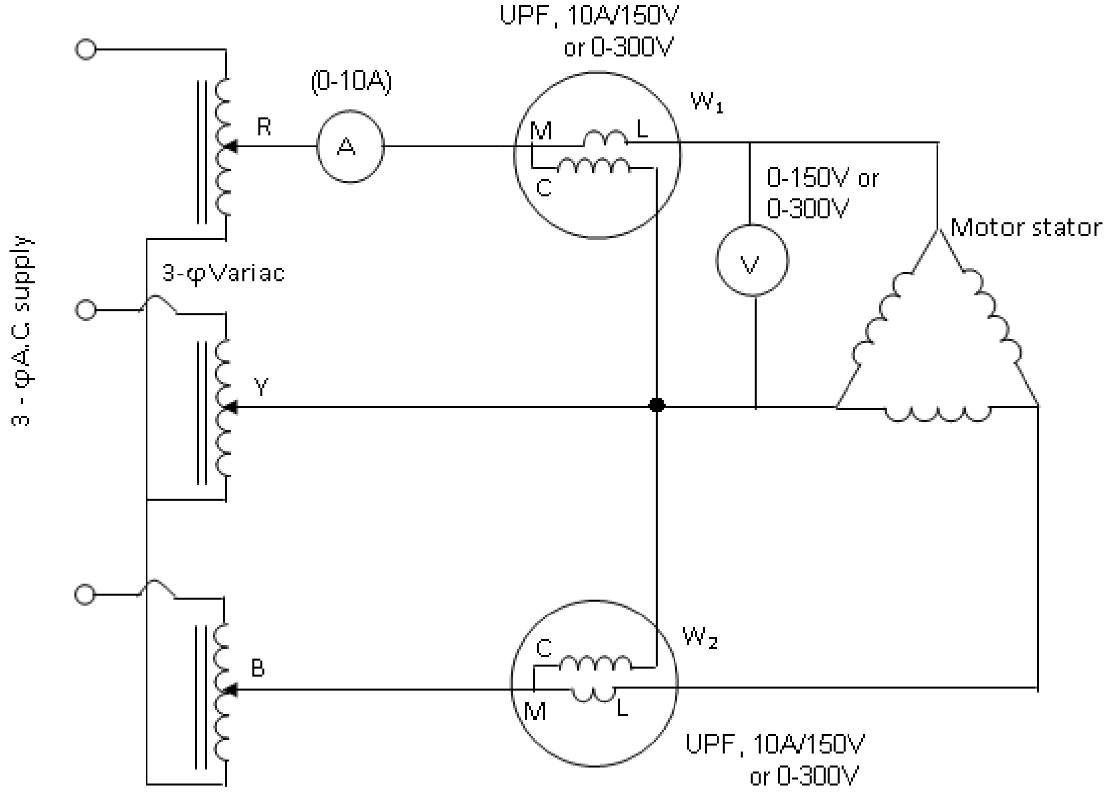


FIG. 5.1B Connections for Blocked-Rotor Test.

Circuit for Load Test:

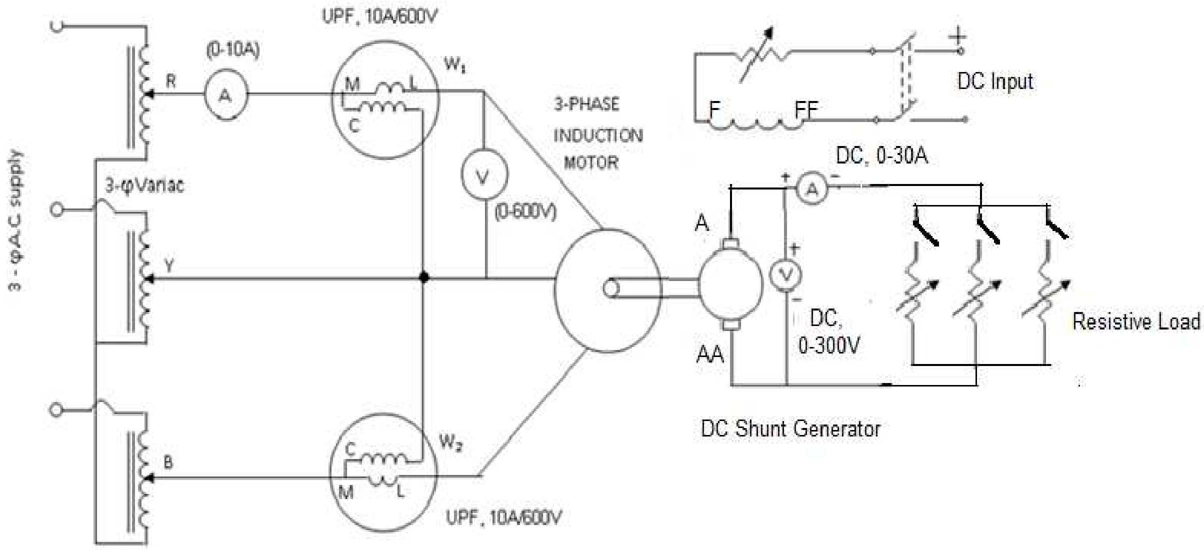


FIG. 5.2: Connections for load test on a three -phase squirrel cage induction motor

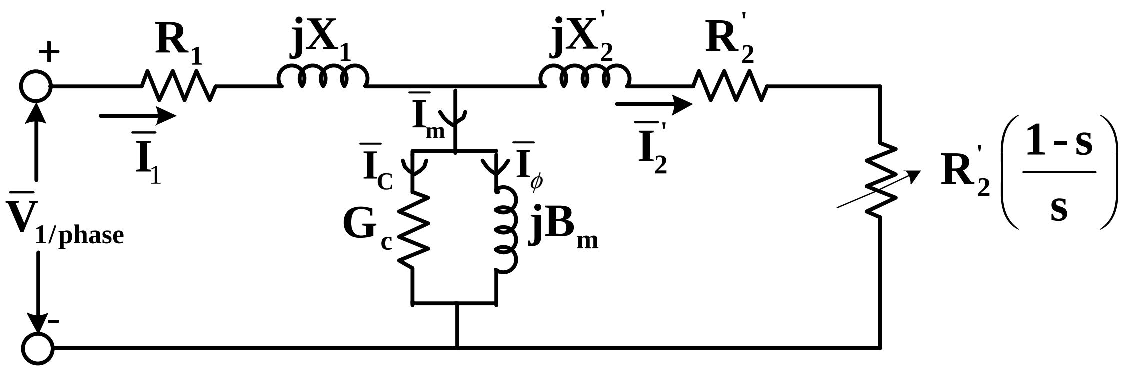


Fig.5.3 One phase Equivalent Circuit of 3-phase Induction Motor

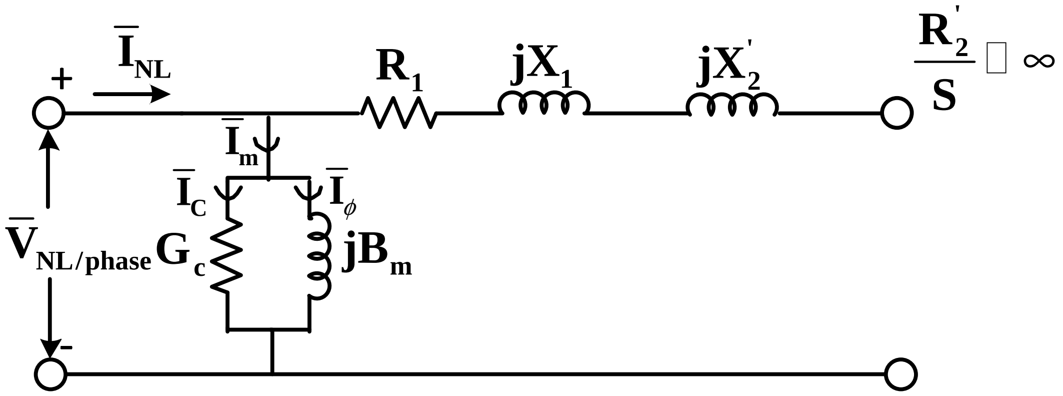


Fig.5.4 One phase Equivalent Circuit of 3-phase Induction Motor under No Load Test

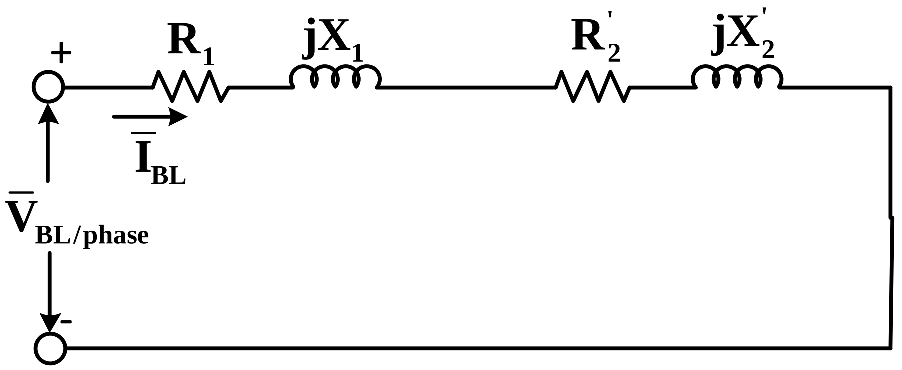


Fig.5.5 One phase Equivalent Circuit of 3-phase Induction Motor under Blocked Rotor Test