SINGLE PHASE INDUCTION MOTOR
UNIT- V

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Single Phase Induction Motor

No load and blocked rotor tests

Lecture No. 4 & 5

NO LOAD AND BLOCKED ROTOR TESTS

The parameter of the equivalent circuit of single – phase induction motor can be determined from the blocked – rotor and no – load tests. These tests are performed with auxiliary winding kept open, except for the capacitor – run motor.

Blocked – rotor test

In this test the rotor is at rest (blocked). A low voltage is applied to the stator so that rated current flows in the main winding. The voltage (V_{scr}), current(I_{scr}) and power input (P_{scr}) are measured. With the rotor blocked, s =1 the impedance $\frac{X_M}{2}$ in the equivalent circuit is so large compared with $(\frac{R'_2}{2} + j\frac{X'_2}{2})$ that it may be neglected from the equivalent circuit. Therefore the equivalent

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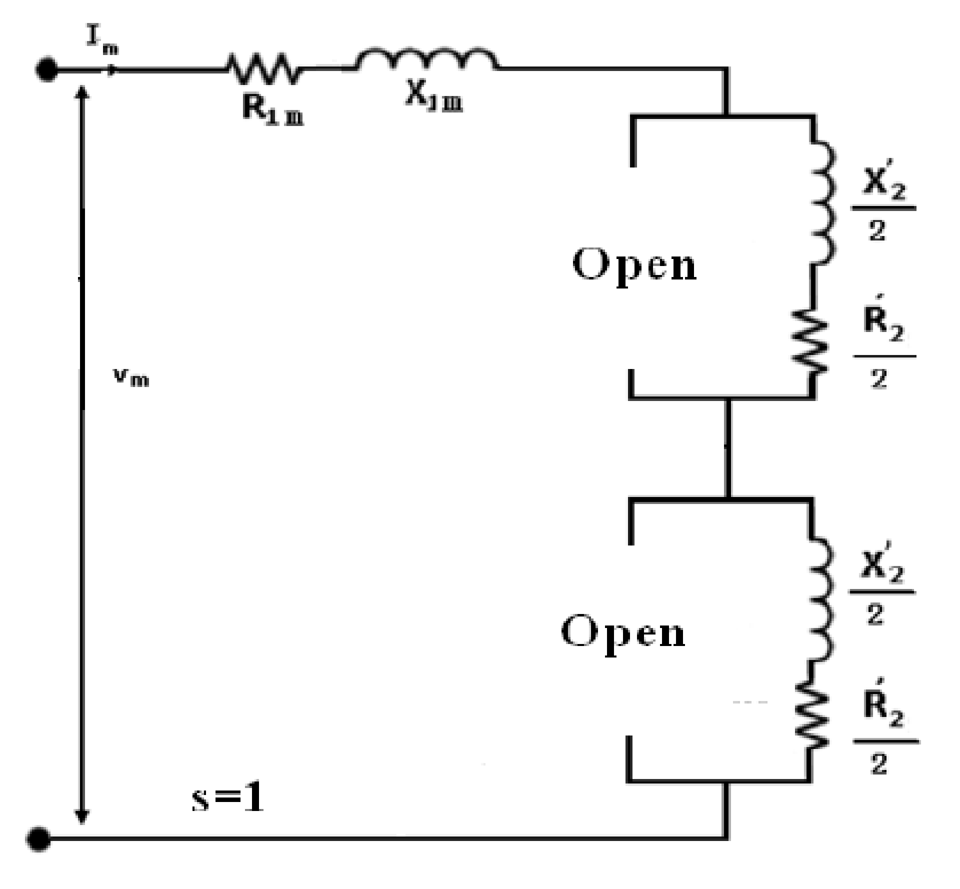

$$Z_e = \frac{V_{scr}}{I_{scr}}$$

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From above fig., the equivalent series resistance R_e of the motor is

$$R_e = R_{1m} + \frac{\acute{R}_2}{2} + \frac{\acute{R}_2}{2} = R_{1m} + \acute{R}_2 = \frac{P_{scr}}{I_{scr}^2}$$

Since the resistance of the main stator winding R_{1m} is already measured, the effective rotor resistance at line frequency is given by

$$\acute{R}_2 = R_e - R_{1m} = \frac{P_{scr}}{I_{scr}^2} - R_{1m}$$

CONT…

$$X_e = X_{1m} + \frac{X_2'}{2} + \frac{X_2'}{2} = X_{1m} + X_2'$$

Since the leakage reactance X_{1m} and X_2' cannot be separated out we make a simplifying assumption that $X_{1m} = X_2'$.

$$\therefore \qquad X_{1m} = X_2' = \frac{1}{2} X_e = \frac{1}{2}\sqrt{Z_e^2 - R_e^2}$$

Thus, from blocked - rotor test, the parameters R_2', X_{1m} , X_2' can be found if R_{1m} is known.

CONT….

No - load test

The motor is run without load at rated voltage and rated frequency. The voltage(V_o), current(I_o) and input power (P_o) are measured. At no load, the slip s is very small close to zero and $\frac{\acute{R}_2}{2s}$ is very large as compared to $\frac{X_M}{2}$.

The resistance $\frac{\acute{R}_2}{2(2-S)} \cong \frac{\acute{R}_2}{4}$ associated with the backward rotating field is so small as compared to $\frac{X_M}{2}$, that the backward magnetizing current is negligible. Therefore, under no load conditions, the equivalent circuit becomes as shown in fig.

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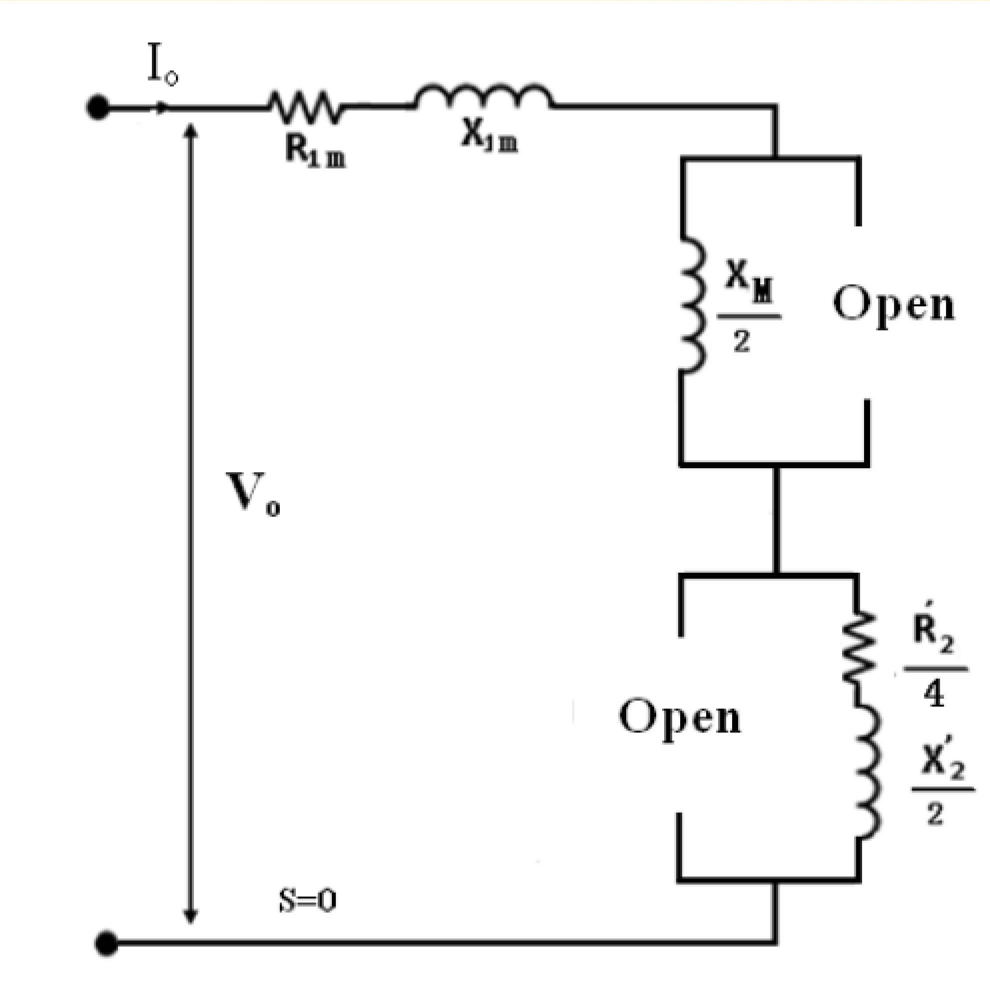

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$$X_o = X_{1m} + \frac{X_M}{2} + \frac{\acute{X}_2}{2}$$

Since X_{1m} and $\acute{X}_2$ are already known from the blocked rotor test, the magnetizing reactance X_M can be calculated from above equation.

And $$X_o = Z_o \sin \emptyset_o = Z_o \sqrt{1 - \cos^2 \emptyset_o}$$

$$\cos \emptyset_o = \frac{P_o}{V_0 I_o}$$

$$Z_o = \frac{V_0}{I_0}$$

CONT…

Example

A 220 V, single – phase induction motor gave the following te
results:

Blocked – rotor test : 120V, 9.6A, 460W

No – load test : 220V, 4.6A, 125W

The stator winding resistance is 1.5Ω, and during the blocked rotor test, the starting winding is open. Determine the equivale circuit parameters. Also, find the core, fraction and winda losses.

Solution

Blocked – rotor test

V_{scr}=120V, I_{scr} = 9.6A , P_{scr}=460W

$$Z_e = \frac{V_{scr}}{I_{scr}} = \frac{120}{9.6} = 12.5\Omega$$

$$R_e = \frac{P_{scr}}{I_{scr}^2} = \frac{460}{(9.6)^2} = 4.99\Omega$$

$$X_e = \sqrt{Z_e^2 - R_e^2} = \sqrt{(12.5)^2 - (4.99)^2} = 11.46\Omega$$

$$X_{1m} = \acute{X}_2 = \frac{1}{2}X_e = \frac{1}{2} * 11.46 = 5.73\Omega$$

$$R_{1m} = 1.5\Omega$$

$$R_e = R_{1m} + \acute{R}_2$$

$$\acute{R}_2 = R_e - R_{1m} = 4.99 - 1.5 = 3.49\Omega$$

No – load test: V_o=220V, I_o = 4.6A , P_o=125W

$$\cos\emptyset_o = \frac{P_o}{V_0 I_o} = \frac{125}{220 * 4.6} = 0.1235$$

$$\therefore \quad \sin\emptyset_o = 0.9923$$

$$Z_o = \frac{V_0}{I_0} = \frac{220}{4.6} = 47.83\Omega$$

$$\therefore \quad X_o = Z_o \sin\emptyset_o = 47.83 * 0.9923 = 47.46\Omega$$

Core, fraction and windage losses

=power input to motor at no load – no load copper loss

$$= P_o - I_o^2\left(R_{1m} + \frac{\acute{R}_2}{4}\right)$$

$$= 125 - (4.6)^2\left(1.5 + \frac{3.49}{4}\right) = 74.8W$$