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BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

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MACHINES AND DRIVES I LAB REPORT

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Chapter 1

Experiment to determine the transformation ratio and the equivalent circuit parameters of a single phase transformer.

1.1 Objectives

i. To determine the transformation ratio, k.

ii. To determine the equivalent circuit parameters.

1.2 List of Apparatus

i. Single phase transformer

ii. Variac

iii. AC ammeters and voltmeters

iv. Wattmeter

1.3 Theory

It is well known that the equivalent circuit of a single phase transformer can be approximately represented as shown below. The parameters r_0 and x_0 which take into account the two components of the no load current can be determined by conducting an open circuit test. The parameters r_1 and x_1 are determined from the short circuit test.

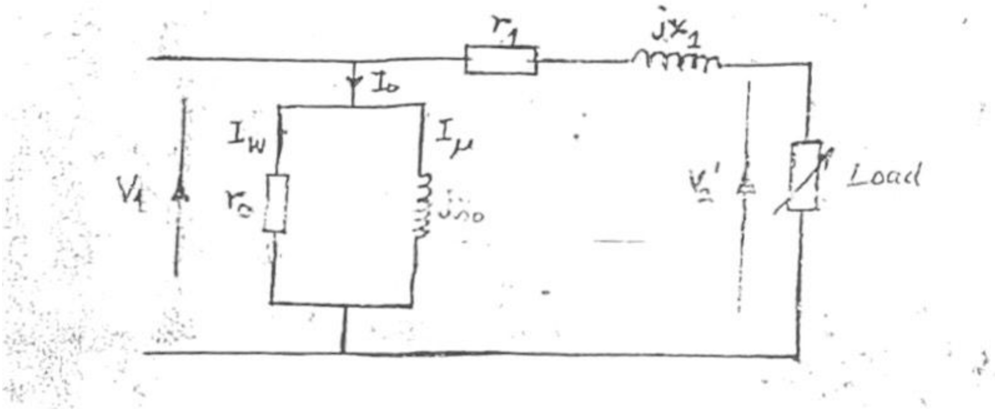


Figure 1.1: Single phase transformer equivalent circuit

1.4 Procedures

1.4.1 Ratio Test

1. Connect the circuit shown in 1.2 below.

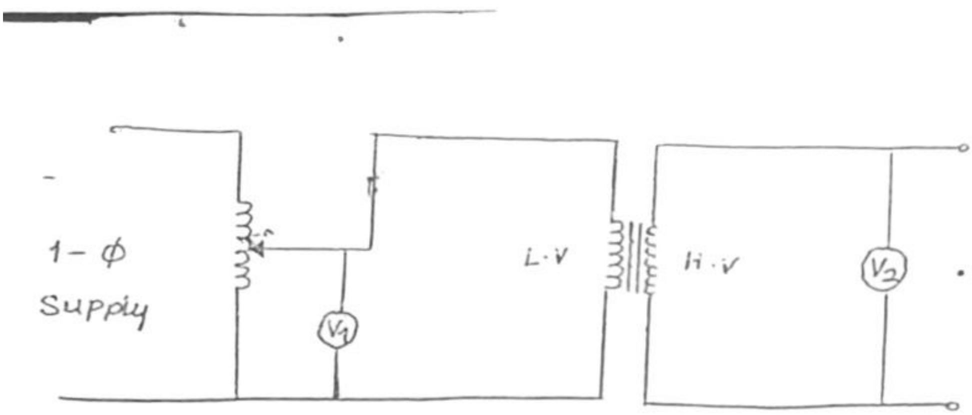


Figure 1.2: Single phase transformer ratio test

2. Vary the output of the variac from 30V to 90V in steps of 90V.
3. Measure and record the voltage on the low voltage and high voltage sides of the transformer.
4. Record the results.

Table 1.1: Table of results for ratio test

LV Voltage , V_1	HV Voltage, V_2	$k = V_2/V_1$
30	60	2.00
40	80	2.00
50	100	2.00
60	130	2.17
70	150	2.14
80	170	2.13
90	185	2.06

1.4.2 Open Circuit Test

1. Make connections as shown in 1.3 below.

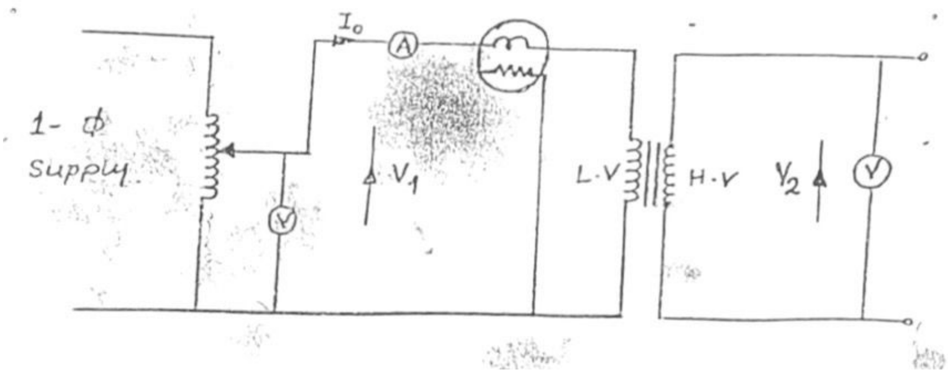


Figure 1.3: Single phase transformer test

2. Apply rated voltage at the low voltage side of the transformer by varying the output of the variac.
3. Measure and record the corresponding power input, W, on the LV side, the power factor and the voltage on the HV side.
4. The procedure is repeated for different input voltages.
5. The results are recorded in the table below.

Table 1.2: Table of results for open circuit test

V_1	P_0	I_0	V_2	$cos\Phi_0 = P_0/(V_1 I_0)$
30	10	1.5	48	0.2222
40	50	4.3	150	0.2907
50	210	18	162	0.2333
55	360	37	180	0.1769

6. Determine the open circuit parameters of your circuit

   The open circuit parameters are tabulated in the table above

1.4.3 Short Circuit Test

1. Make the connections as shown in the 1.4 , with the LV side of the transformer short-circuited.

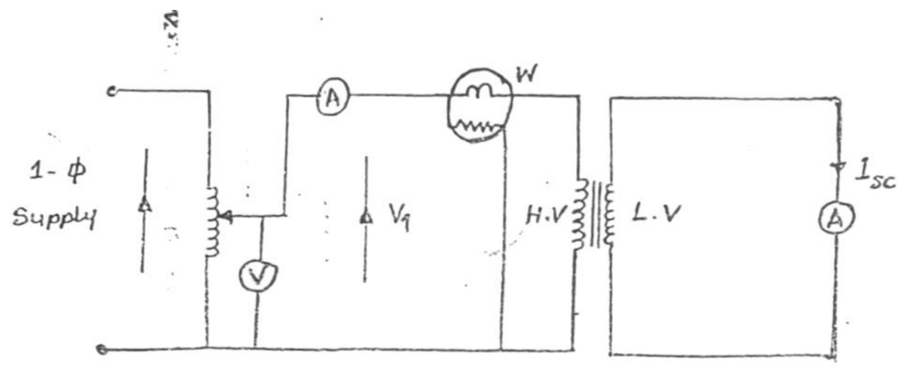


Figure 1.4: Short circuit single phase transformer tests

2. Apply an input voltage, V_1 so that the rated current flows on the LV side of the transformer.

3. Measure and record the power input, P_{SC}, the power factor, and the corresponding current, I on the HV.

4. Ensuring the input voltage does not exceed 8% of the rated HV voltage.

5. THe procedure is repeated for different lower values of short circuit currents, I_{SC}.

6. The results are tabulated below.

Table 1.3: Table of results for short circuit tests

V_1	I_{SC}	P_{SC}	I	$cos\Phi = P_{SC}/(V_1 I)$
2	0	0	0	0.0000
4	2	0	1	0.0000
6	8	5	4	0.2083
8	11	15	5.2	0.3606
10	14	25	7.5	0.3333
12	17	40	9	0.3704
14	20	60	10	0.4286
16	24	80	12	0.4167
18	26.5	110	13.5	0.4527
20	30	130	15	0.4333

7. Comment on your results. Determine the short circuit parameters of the transformer.

   For small variation in voltages, there's a significant increase in the current. The short circuit parameters are tabulated in the table above

Chapter 2

Experiment to determine parameters and performance characteristics of Induction Motors.

2.1 Objectives

1. To determine equivalent circuit parameters of the induction motor from measurements.
2. To predict the performance characteristics of the motor.

2.2 List of Apparatus

1. Power supply mod AV -1/V
2. 4 Variable resistors RC3-PT
3. Multifunctional digital instrument AZ VIP 10/EV
4. Digital Torque and speed measurement unit Um-G1/EV
5. 3 phase induction motor mod P-4/EV

2.3 Theory

Induction motors operate by using a rotating magnetic field from the stator to induce currents in the rotor, generating torque. Key motor parameters—like stator and rotor resistances, reactances, and magnetizing reactance—are identified through standard tests: the no-load test, blocked rotor test, and load test. The no-load test evaluates magnetizing current and rotational losses, while the blocked rotor test (with the rotor prevented from rotating) is used to determine rotor and stator resistance and leakage reactances. The load test then assesses the motor's efficiency, power factor, and torque-speed performance under actual load conditions.

From these tests, an equivalent circuit model can be constructed, offering insights into the motor's efficiency, slip, and torque characteristics. This model helps engineers predict motor behavior, optimize performance, and select the right motor for specific applications.

2.4 Procedure

2.4.1 Light Running Test

1. Connect the machine as shown in the fig below.

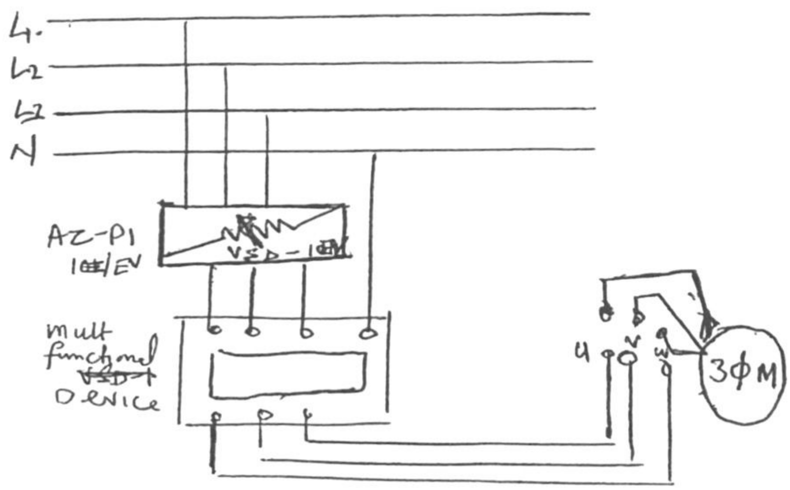


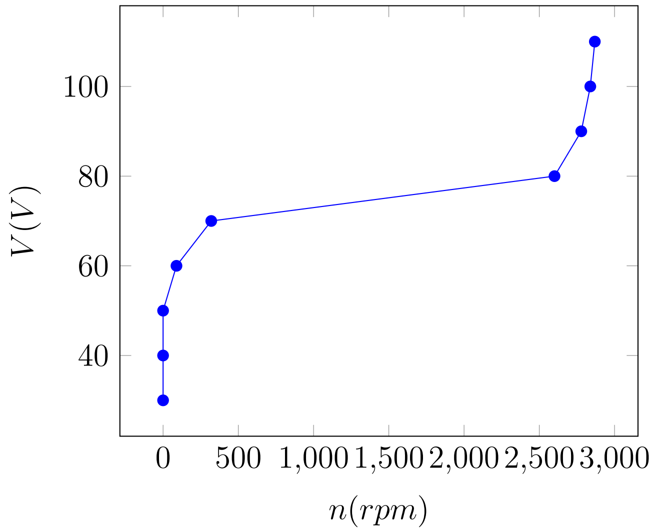
Figure 2.1: Light running test: without load

2. Start the motor by applying normal frequency, reduced voltage and gradually increase the input voltage to its rated value.
3. Note down the readings for voltage, current, power and speed at different voltages.
4. The results are tabulated.

Table 2.1: Table of results for light running test

$V_1(V)$	$I(A)$	$W_1(W)$	$W_2(W)$	$W_3(W)$	$n(rpm)$	$\rho = (W_1 - W_2)/W_1$
30	0.584	3.80	4.40	3.80	0	-0.1579
40	0.911	9.70	10.40	9.20	0	-0.0722
50	1.246	18.30	19.40	17.30	0	-0.0601
60	1.597	31.00	30.20	27.90	89	0.0258
70	1.890	45.00	44.00	40.60	320	0.0222
80	0.870	33.30	33.50	29.70	2601	-0.0060
90	0.673	27.50	29.20	24.80	2779	-0.0618
100	0.566	26.50	28.30	24.20	2839	-0.0679
110	0.523	27.20	27.10	23.00	2869	0.0037

5. Plot V against n.



2.4.2 Blocked Rotor

1. The connection is setup as shown below, block the rotor with a load cell.

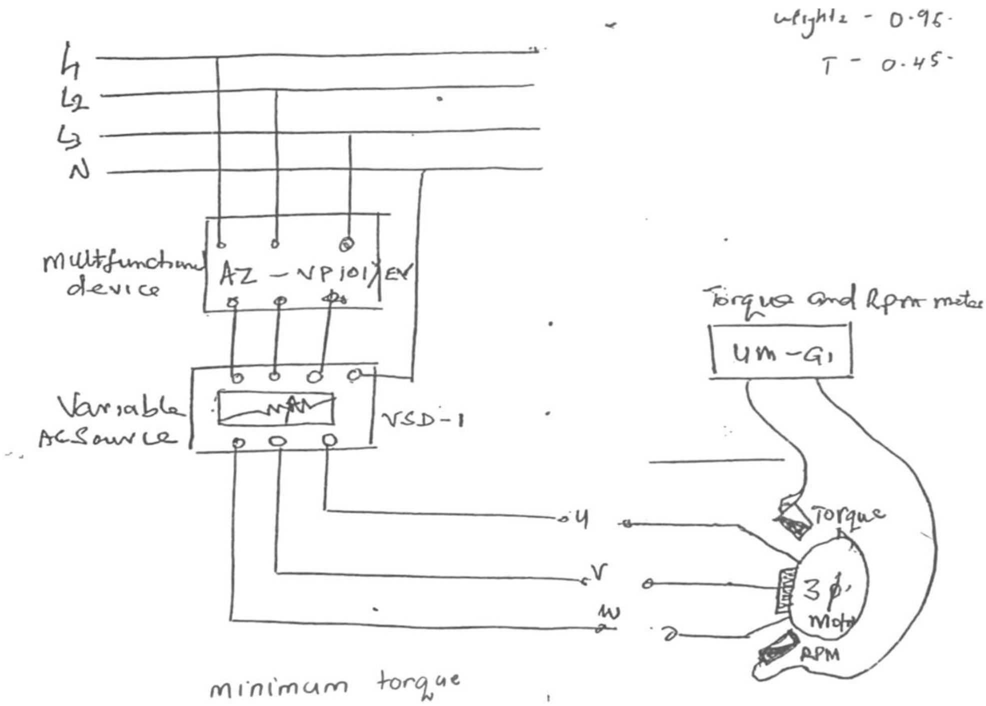


Figure 2.2: Blocked rotor

2. Measure:

   i. the torque

   torque = 0.26 Nm

   ii. the force

   force = 0.96 kg

   iii. Mechanical Power Developed P(W) = T(Nm) ω

where $\omega = \frac{2\pi n}{60}$

using the least value of n at V = 50V

n = 80 rpm

$$\omega = \frac{2.\pi.80}{60}$$
$$\omega = 8.3776$$
$$P = 0.26.8.3776$$
$$P = 2.178W$$

Chapter 3

Errors

In conducting practical tests on transformers and induction motors, various sources of errors can affect the accuracy of measurements and results. Key sources of errors in transformer and motor testing include:

3.1 Sources of Errors

1. **Instrument Accuracy**: Inaccuracies in voltmeters, ammeters, and wattmeters can lead to measurement errors during open and short circuit tests.
2. **Connection Errors**: Poor connections or loose terminals can cause significant deviations in test results, especially during the high-current blocked rotor test.
3. **Temperature Effects**: Changes in winding resistance due to temperature variations can affect results in short circuit and blocked rotor tests.

3.2 Error Minimization

To minimize errors during the experiments, the following steps should be taken:

1. **Instrument Calibration**: Ensure all measuring instruments are calibrated before testing to reduce reading errors.
2. **Secure Connections**: Tighten all connections securely to avoid contact resistance that could affect results.
3. **Temperature Control**: Conduct tests at stable temperatures or record temperature data to account for changes in resistance.

Chapter 4

Conclusion

The practical lab sessions on transformer and induction motor testing provided a solid foundation for understanding core principles of machine characteristics. By performing open and short circuit tests on transformers, we were able to accurately determine parameters like the equivalent impedance and transformer ratio. The light running and blocked rotor tests on induction motors allowed us to determine their key characteristics, such as slip and torque, under different operating conditions.

Overall, the experiments highlighted the importance of accurate measurement techniques, error minimization, and methodical setup for obtaining reliable data on machine performance. These hands-on exercises are crucial for developing practical skills in electrical machine testing and diagnostics.

Bibliography

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