

Experiment No.: _1__

Date: ____

Aim of the Experiment- To dismantle a DC machine.

Objective:

1. To dismantle a DC machine carefully.
2. To study and identify the various parts of a DC machine.

Apparatus Required:

Sl. No.	Apparatus	Quantity
1	DC Machine	1
2	Screwdriver set	1 set
3	Spanner set	1 set
4	Soft hammer	1
5	Puller (if needed)	1
6	Brush/Cloth	1

Theory:

A DC machine consists of two major parts:

1. **Stator (stationary part):** Provides the magnetic field through field poles and yoke.
2. **Rotor/Armature (rotating part):** Consists of the armature core, windings, and commutator, which produce or utilize electrical energy.

Main parts of DC machine:

- **Yoke:** Outer frame, provides mechanical support and magnetic path.
- **Field Poles:** Electromagnets bolted inside the yoke.
- **Field Windings:** Wound on poles, create magnetic flux.
- **Armature Core:** Laminated steel core with slots to house windings.
- **Armature Windings:** Conductors placed in slots, carry current.
- **Commutator:** Segmented copper ring, provides rectification and current direction reversal.
- **Brushes & Brush Holders:** Carbon brushes maintain contact with commutator.
- **End Shields & Bearings:** Support the rotor shaft.

Procedure:

1. Ensure the machine is disconnected from the supply.
2. Remove the end covers carefully using spanner/screwdriver.
3. Take out the brush holders and brushes.
4. Disconnect field winding leads.
5. Remove the commutator end shield.
6. Withdraw the armature carefully without damaging the windings.
7. Identify each part: yoke, poles, field coils, armature, commutator, brushes, bearings, shaft.
8. Clean and observe the condition of each part.
9. After study, reassemble the machine in reverse order.

Observations:

Parts identified during dismantling:

1. Yoke
2. Poles
3. Field winding
4. Armature core
5. Armature winding
6. Commutator
7. Brushes & brush holders
8. Bearings
9. Shaft
10. End shields

Conclusion:

The DC machine was successfully dismantled. All constructional parts were identified and studied.

Experiment No.: 2

Date: ____

Aim of the Experiment:-To reverse the direction of rotation of a DC shunt motor.

Objective:

1. To study the effect of reversing supply connections in a DC shunt motor.
2. To practically verify the method of changing motor rotation.

Apparatus Required:

Sl. No.	Apparatus	Quantity
1	DC Shunt Motor (Lab model)	1
2	DC Supply (0–220 V)	1
3	Voltmeter (0–300 V)	1
4	Ammeter (0–10 A)	1
5	Rheostat (Field)	1
6	DPDT Switch / Reversing Switch	1
7	Connecting Wires	Required

Theory:

- The **direction of rotation** of a DC motor depends on:
 - **Field flux** (created by field winding).
 - **Armature current** (direction through the armature conductors).
- From **Fleming's Left-Hand Rule**, torque direction depends on the interaction of flux and current.
- To reverse motor direction, either:
 1. Reverse the **field connections**, OR
 2. Reverse the **armature connections**.
- **But both must not be reversed together**, else the direction remains the same.

Circuit Diagram:

(Draw a neat circuit diagram of a DC shunt motor with supply, rheostat, ammeter, voltmeter, and reversing switch for either armature or field terminals.)

Procedure:

1. Connect the circuit as per the diagram with field rheostat in maximum resistance position.
2. Switch ON the supply and allow the motor to run at no load.
3. Note the initial direction of rotation.
4. Stop the motor.
5. Reverse the connections of either:
 - Armature terminals, OR
 - Field terminals.
6. Switch ON again and observe the new direction of rotation.
7. Record observations.
8. Repeat by reversing the other set of terminals.

Observations:

Case Connections Reversed Direction of Rotation

Case Connections Reversed Direction of Rotation

1	Armature	Reversed
2	Field	Reversed
3	Both armature & field	Same as original

Precautions:

- Always bring the field rheostat to maximum resistance before starting.
 - Never reverse connections while the motor is running.
 - Ensure proper supply polarity and tight connections.
 - Use a DPDT switch for safe reversal.
 - Do not overload the motor.
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Result:

The experiment verified that the direction of rotation of a DC shunt motor can be reversed by changing the connections of either the field winding or the armature winding (but not both simultaneously).

Experiment No.: 3

Date: ____

Aim of the Experiment:- Control of Speed of a DC Shunt Motor by Field Flux & Armature Voltage Control methods.

Objective:

To study and compare the speed control of a DC shunt motor using field control and armature voltage control methods.

Apparatus Required

Sl. No.	Apparatus	Rating / Range	Quantity
1.	DC Shunt Motor	220 V, ___ HP	1
2.	DC Supply	220 V	1
3.	Field Rheostat	Suitable	1
4.	Armature Rheostat / Variac	Suitable	1
5.	Ammeter (Armature)	0–___ A	1
6.	Ammeter (Field)	0–___ A	1
7.	Voltmeter	0–300 V	2
8.	Tachometer	0–3000 rpm	1
9.	Connecting leads, switch, fuses	—	—

Theory

- Back emf of motor:

$$E_b = V_a - I_a R_a \quad E_b = V_a - I_a R_a$$

- Speed of motor:

$$N \propto E_b \Phi N \propto \frac{E_b}{\Phi} \quad N \propto \Phi E_b$$

- **Field control method:** By varying field current using rheostat, flux changes. Decreasing flux increases speed. Suitable for above rated speed.
- **Armature voltage control method:** By varying armature voltage, speed changes linearly with voltage. Suitable for below rated speed.

Procedure

A. Field Control

1. Connect the circuit as per diagram.
2. Keep armature voltage constant at rated value.
3. Vary field rheostat to change field current in steps.
4. For each step, note: field current, armature current, armature voltage, and speed.
5. Tabulate readings.

B. Armature Voltage Control

1. Connect the circuit as per diagram.
2. Keep field current constant at rated value.
3. Vary armature voltage in steps.
4. For each step, note: armature voltage, armature current, and speed.
5. Tabulate readings.

Observation Tables

Table 1 — Field Control

Sl. No.	Field Current (A)	Armature Current	Armature Voltage	Speed (rpm)
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		(A)	(V)	

Table 2 — Armature Voltage Control

Sl. No.	Armature Voltage (V)	Armature Current (A)	Field Current (A)	Speed (rpm)

Result

1. In **field control**, speed increases when field current decreases.
2. In **armature voltage control**, speed decreases almost linearly with armature voltage.
3. Field control is used for above rated speed; armature voltage control is used for below rated speed.

Precautions

1. Do not reduce field current to zero → motor may overspeed.
2. Apply load gradually and within limits.
3. Switch off supply before changing connections.
4. Rheostat ratings should be adequate.

Conclusion

Speed control of a DC shunt motor is successfully achieved using both methods. Armature voltage control provides smooth and safe regulation, while field control gives wide speed variation but reduces torque capability.

Experiment No.: ____

Date: ____

Aim of the Experiment:- To perform the **brake test on a DC series motor.**

Apparatus Required:

Sl. No.	Apparatus	Rating	Quantity
1	DC Series Motor	220 V	1
2	Voltmeter	0–300 V DC	1
3	Ammeter	0–30 A DC	1
4	Loading Rheostat / Brake Drum	—	1
5	Spring Balance (S1, S2)	0–10 kg	2
6	Tachometer	0–3000 rpm	1
7	Connecting Wires	—	Required

Theory:

A **brake test** is a **direct loading test** used to determine the performance of a DC motor.

A **brake drum** is fitted to the motor shaft and a rope is wound around it. Two spring balances measure the load.

Torque Calculation

Let:

- W_1 = Pull on tight side (kg)
- W_2 = Pull on slack side (kg)
- R = Radius of brake drum (m)

$$T = (W_1 - W_2) \times g \times R \text{ (N-m)}$$

Output Power

$$P_{out} = \frac{2\pi NT}{60} \text{ Watts}$$

Input Power

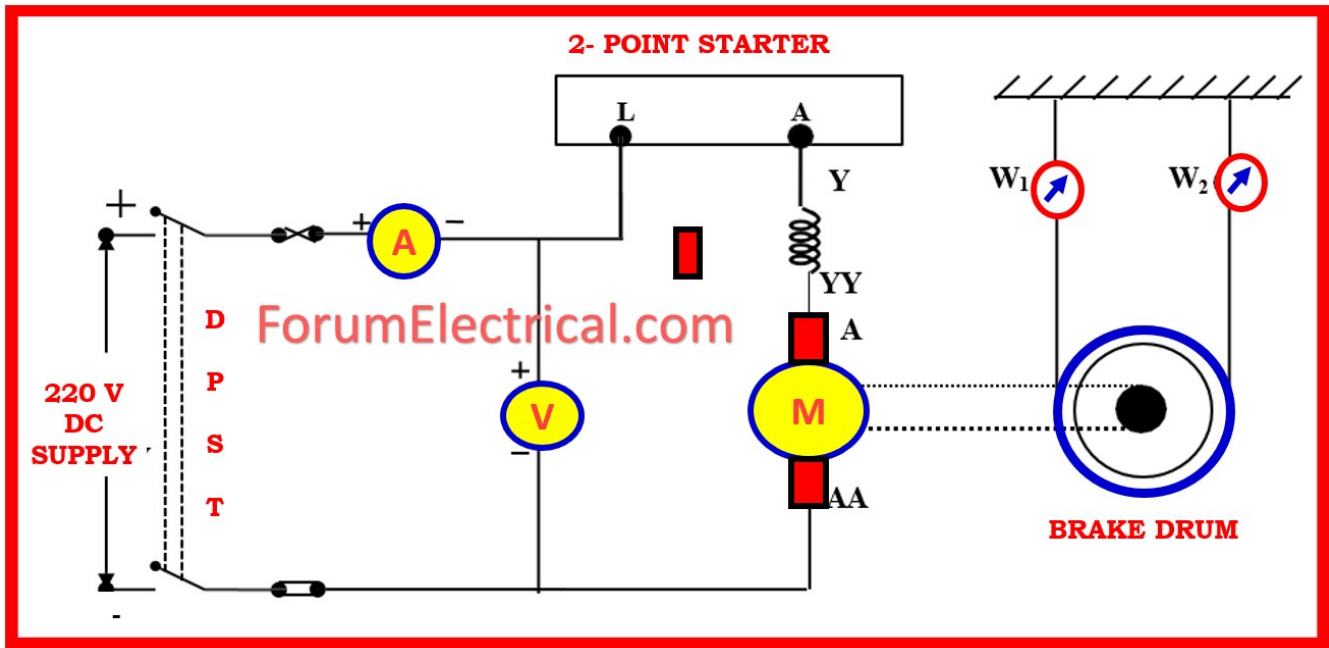
$$P_{in} = V \times I$$

Efficiency

$$\eta = \frac{P_{out}}{P_{in}} \times 100$$

As load increases, current increases, torque increases, speed decreases.

Circuit Diagram:



Procedure:

- | Step | Action |
|------|---|
| 1 | Connect the circuit as per the diagram. |
| 2 | Ensure the belt/rope is properly placed around the brake drum. |
| 3 | Switch ON the DC supply and allow motor to reach normal speed. |
| 4 | Gradually tighten the loading belt using the brake arrangement. |
| 5 | Note down readings of V, I, S₁, S₂, speed (N) for different loads. |
| 6 | Increase load in steps and record all observations. |
| 7 | Do not overload the motor beyond rated current. |
| 8 | Switch OFF supply after taking all readings. |

Observation Table:

Sl. No.	Voltage V (V)	Current I (A)	S ₁ (kg)	S ₂ (kg)	Speed N (rpm)	Torque T (N-m)	Output Power (W)	Efficiency (%)
1								
2								
3								
4								

Conclusion :

The brake test was successfully performed on the DC series motor. The **torque, output power, input power, and efficiency** were calculated for different loads, and performance characteristics were obtained.

Aim- To check the proper functioning of a single-phase transformer

Apparatus Required

Sl. No.	Apparatus	Quantity
1	Single-phase transformer (e.g., 230/115 V or 230/12 V)	1
2	Voltmeter (AC)	2
3	Ammeter (AC)	1
4	Autotransformer (Variac)	1
5	Connecting wires	As required
6	Wattmeter (optional)	1

Name Plate Details of Transformer

- Rated Power: _____ VA
- Primary Voltage: _____ V
- Secondary Voltage: _____ V
- Frequency: 50 Hz
- Connection Type: Core Type / Shell Type
- Manufacturer: _____

Theory

A transformer is a static device that transfers electrical power from one circuit to another through electromagnetic induction.

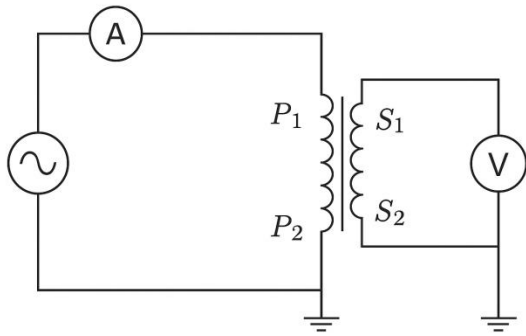
Its performance is checked by:

1. **Applying rated voltage on primary** and measuring secondary voltage.
2. **Turns Ratio Test:** Ratio= V_1/V_2
3. **Polarity Test:** To ensure correct additive/subtractive polarity.
4. **No-Load Test:** To measure no-load current and core losses.
5. **Checking for abnormal heating, noise, or vibrations.**

For an ideal transformer:

$$V_1 / V_2 = N_1 / N_2$$

Circuit Diagram:



Observation Table:

Primary Voltage V₁: 230 V Secondary Voltage V₂: 115 V / 12 V Voltage Ratio: 2:1 / 19:1

Conclusion:

The transformer is functioning properly as the measured ratio matches the expected ratio.

Aim of the experiment

To determine the **voltage regulation** and **efficiency** of a single-phase transformer using the **direct loading method**.

Apparatus Required

Sl. No.	Apparatus	Specification
1	Single-phase transformer	1 kVA, 230/115 V
2	Voltmeter (AC)	0–300 V
3	Ammeter (AC)	0–10 A
4	Wattmeter	0–300 V, 10 A
5	Resistive load bank	As required
6	Connecting wires	—

3. Theory

Voltage Regulation

It indicates how much the secondary voltage drops when load is applied.

$$\text{Regulation(\%)} = \frac{V_{\text{no load}} - V_{\text{full load}}}{V_{\text{full load}}} \times 100$$

Efficiency

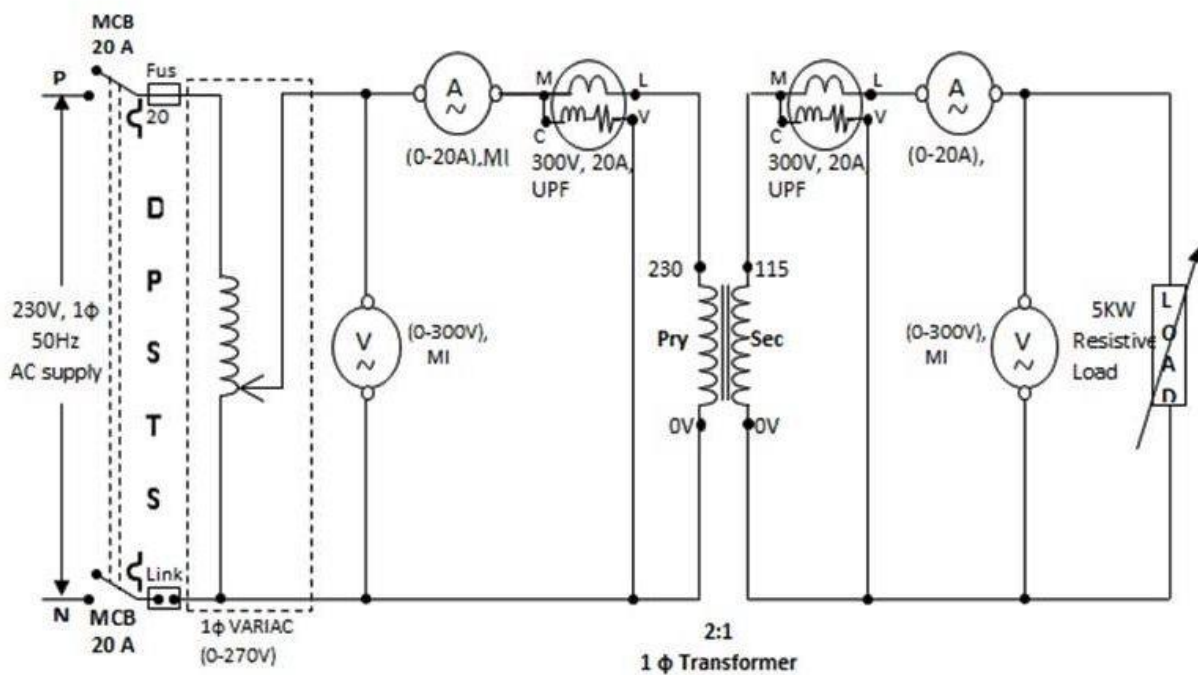
$$\eta = \frac{\text{Output Power}}{\text{Input Power}} \times 100$$

$$\eta = \frac{V_2 I_2 \cos \phi}{V_1 I_1}$$

Where:

- V_2, I_2 = Secondary voltage & current
- $\cos \phi$ = Power factor (unity for resistive load)

circuit diagram



Procedure

1. Connect the transformer as per the circuit diagram.
2. Apply rated voltage to primary winding.
3. Keep secondary initially open; note no-load voltage.
4. Gradually apply load in steps using load bank.
5. For each step, note:
 - Primary voltage V_{1V_1V1}
 - Primary current I_{1I_1I1}

- Primary power WWW
 - Secondary voltage V_{2V_2V2}
 - Secondary current I_{2I_2I2}
6. Continue up to full load.
 7. Calculate regulation and efficiency at each load.
 8. Switch off the supply.

Observation Table with Readings (Sample)

Transformer rating: 230/115 V, 1 kVA

Load: Resistive (unity power factor)

Load (%)	V _{1V_1V1} (V)	I _{1I_1I1} (A)	Wattmeter W (W)	V _{2V_2V2} (V)	I _{2I_2I2} (A)	Output Power V _{2I2V_2 I_2V2I2} (W)
0% (No load)	230	0.30	45	115	0	0
25%	230	1.50	290	113	2.2	248.6
50%	230	2.90	550	111	4.3	477.3
75%	230	4.30	820	109	6.5	708.5
100%	230	5.80	1090	107	8.7	930.9

7. Calculations

(A) Voltage Regulation at Full Load

$$\text{Regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

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$$= \frac{115 - 107}{107} \times 100$$

$$= \frac{8}{107} \times 100 = 7.47\%$$

(B) Efficiency at Full Load

$$\eta = \frac{\text{Output Power}}{\text{Input Power}} \times 100$$

Where,

Input Power at full load = Wattmeter reading = 1090 W

Output Power = V₂I₂ = 107 × 8.7 = 930.9 W

$$\eta = \frac{930.9}{1090} \times 100 = 85.4\%$$

Conclusion

1. Voltage Regulation at Full Load = 7.47%
2. Efficiency at Full Load (Unity PF) = 85.4%

Aim of the Experiment:

To perform Open Circuit (OC) and Short Circuit (SC) tests on a single-phase transformer to determine:

1. Equivalent circuit parameters
2. Voltage regulation
3. Efficiency at various load conditions

APPARATUS REQUIRED

Equipment	Rating	Qty
Single-phase transformer	1 kVA, 230/115 V	1
Voltmeter	0–300 V	1
Ammeter	0–5 A (OC), 0–10 A (SC)	2
Wattmeter	LPF for OC, UPF for SC	2
Variac	0–270 V	1
Connecting wires	–	–

NAME PLATE DETAILS

- Rated power: **1 kVA**
- Primary voltage: **230 V**
- Secondary voltage: **115 V**
- Frequency: **50 Hz**

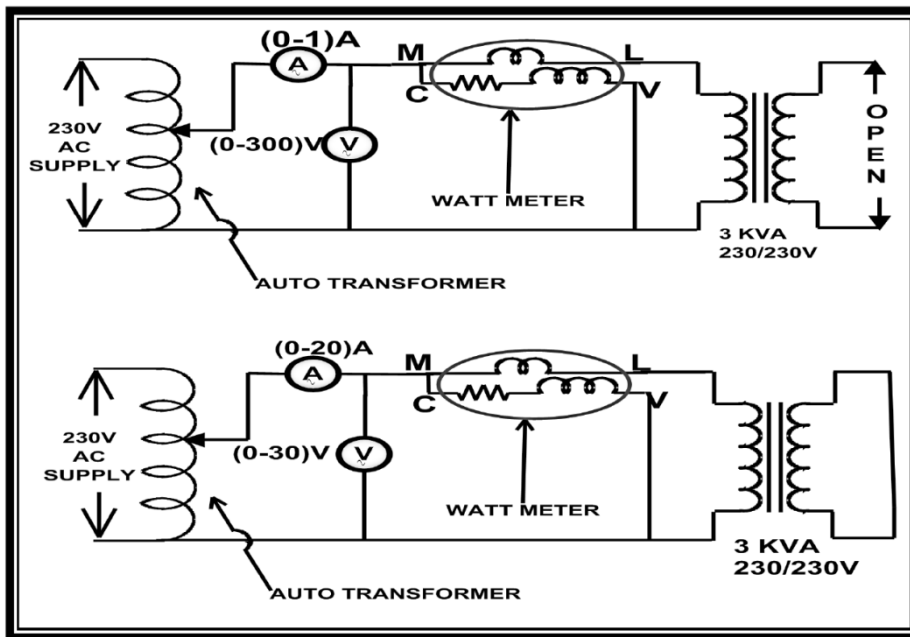
THEORY

Open Circuit Test (OC):

- Secondary is kept **open**.
- Rated voltage applied to the **LV side**.
- Gives **core loss (iron loss) & parameters R_0 and X_0** .

The image is a screenshot of a presentation slide containing the following content:

- Formulas for Open Circuit Test:
$$R_0 = \frac{V_{OC}^2}{W_{OC}}$$
$$X_0 = \sqrt{\left(\frac{V_{OC}}{I_{OC}}\right)^2 - R_0^2}$$
- Section: Short Circuit Test (SC):
 - Secondary terminals are shorted.
 - Reduced voltage applied to HV side to circulate full-load current.
 - Gives full-load copper loss & equivalent impedance (Z).
- Formulas for Short Circuit Test:
$$R_{eq} = \frac{W_{SC}}{I_{SC}^2}$$
$$Z_{eq} = \frac{V_{SC}}{I_{SC}}$$
$$X_{eq} = \sqrt{Z_{eq}^2 - R_{eq}^2}$$
- Section: Voltage Regulation
$$\%VR = R_{eq} \cos \phi + X_{eq} \sin \phi$$
- Section: Efficiency
$$\eta = \frac{\text{Output}}{\text{Output} + \text{Losses}} \times 100$$



(circuit diagram for open circuit test and short circuit test)

PRECAUTIONS

- Apply voltage gradually using variac.
- Ensure the secondary is open during OC test.
- Ensure secondary is shorted firmly during SC test.
- Do not exceed SC test rated current.
- Tight connections to avoid sparking.

OBSERVATION TABLES

A) OPEN CIRCUIT TEST (LV SIDE ENERGIZED)

Sl. No	Voltage V_{OC} (V)	Current I_{OC} (A)	Power W_{OC} (W)
1	40	0.18	16
2	80	0.32	38
3	120	0.46	62
4	160	0.60	88

5 (Rated)	115	0.50	70
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□ Rated OC readings (used for calculations):

$$V_{OC} = 115 \text{ V}, I_{OC} = 0.50 \text{ A}, W_{OC} = 70 \text{ W}$$

SHORT CIRCUIT TEST (HV SIDE ENERGIZED)

Sl. No	Voltage V _{SC} (V)	Current I _{SC} (A)	Power W _{SC} (W)
1	20	2.5	55
2	30	3.8	113
3	40	5.1	210
4	50	6.4	325
5 (Rated)	55	7.0	380

□ Rated SC readings:

$$V_{SC} = 55 \text{ V}, I_{SC} = 7.0 \text{ A}, W_{SC} = 380 \text{ W}$$

CALCULATIONS

A) From OC Test

1. Losses

PT ▾

B) From OC Test

1. Losses

$$W_{OC} = 70W \quad (\text{Core loss})$$

2. R_0 (Magnetizing resistance)

$$R_0 = \frac{V_{OC}^2}{W_{OC}} = \frac{115^2}{70} = 189\Omega$$

3. Z_0 (No-load impedance)

$$Z_0 = \frac{115}{0.5} = 230\Omega$$

4. X_0 (Magnetizing reactance)

$$X_0 = \sqrt{230^2 - 189^2} = 128.6\Omega$$

B) From SC Test

1. Full-load copper loss

$$W_{SC} = 380W$$

2. Equivalent resistance R^e

$$R_{eq} = \frac{380}{7^2} = 7.76\Omega$$

3. Equivalent impedance Z^e

$$Z_{eq} = \frac{55}{7} = 7.86\Omega$$

4. Equivalent reactance X^e

$$X_{eq} = \sqrt{7.86^2 - 7.76^2} = 1.25\Omega$$

8. VOLTAGE REGULATION

At 0.8 Power Factor Lag

$$VR = R_{eq} \cos \phi + X_{eq} \sin \phi$$

$$VR = 7.76(0.8) + 1.25(0.6)$$

$$VR = 6.20 + 0.75 = 6.95\%$$

9. EFFICIENCY (η)

At Full Load:

- Output = 1000 W (since 1 kVA at 1.0 pf)
- Total losses = Iron loss + Copper loss = 70 + 380 = 450 W

$$\eta = \frac{1000}{1000 + 450} \times 100 = 68.9\%$$

10. RESULTS

- Core Loss (OC Test): 70 W
- Copper Loss (SC Test): 380 W
- Equivalent Resistance R^e : 7.76 Ω
- Equivalent Reactance X^e : 1.25 Ω
- Equivalent Impedance Z^e : 7.86 Ω
- Voltage Regulation at 0.8 pf lag: 6.95%
- Full-load Efficiency: 68.9%

