EXPERIMENT No. 1
TESTS ON A SINGLE-PHASE TRANSFORMER

Name ____ ID No.____________________________

Sec.No ______________________ Batch No.____________ Marks obtained________________

Date___________________________ Instructor's signature_____________________________

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1. **Objective:** To determine the parameters of the equivalent circuit of a single-phase transformer and estimate the performance characteristics.

2. **Name plate ratings of the transformer to be tested:**

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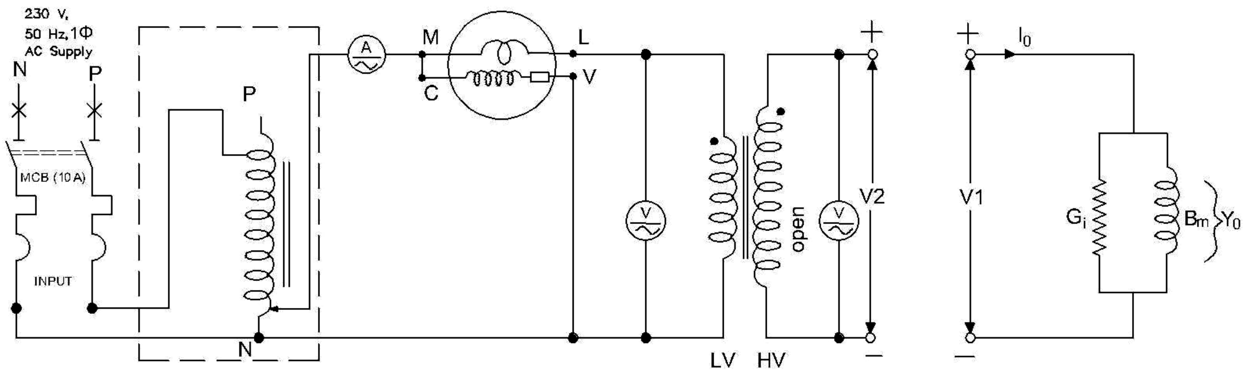
3. **Range of instruments and accessories (standard format)**

S. No.	DESCRIPTION	TYPE	RANGE	MFR. NAME	MFR. NO.

Note: In O.C. test, voltage applied is rated while current drawn is 5-8% of full-load current.

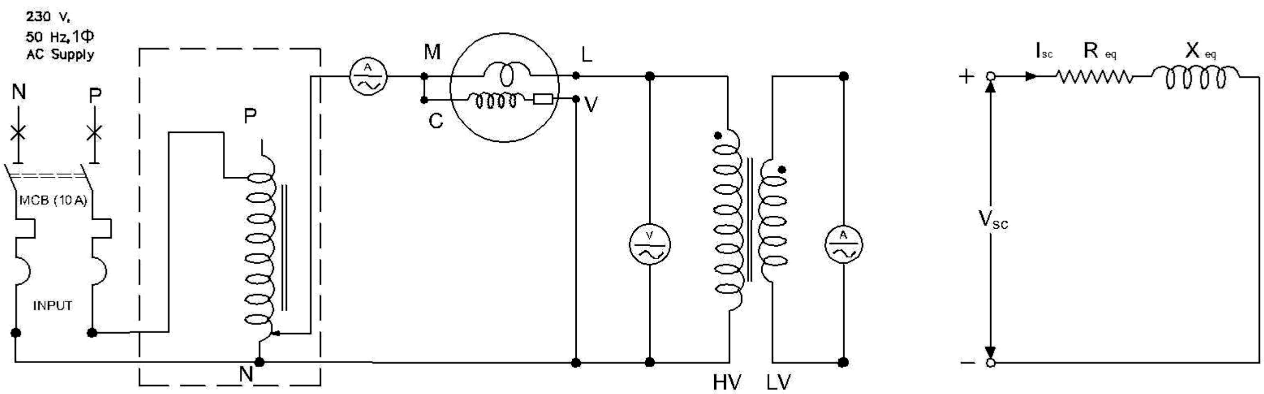
In S.C. test, full-load current is drawn while the voltage applied is 5-8% of rated-voltage.

4. **Circuit Diagrams**



(a) Circuit diagram *(b) Equivalent circuit*

Fig.1.2 O.C. Test; conducted from LV side



(a) Circuit diagram *(b) Equivalent circuit*

Fig.1.3 S.C. Test; conducted from HV side

5. Observations:

a) Voltage ratio (≈ turns ratio) Test

Voltage ratio (≈ turns ratio) = $\dfrac{V_2}{V_1}$ =

b) Open Circuit (O.C.) Test

Readings

Applied voltage (rated), V_1 =

No load current, I_0 =

No load power (= core loss), P_i =

Short-Circuit

Readings

Applied Voltage, V_{SC} =

Input current, I_{SC} =

Input power (=copper loss at rated current), P_{SC} =

6. Calculations

$$Y_0 = \frac{I_0}{V_1} =$$

$$G_i = \frac{P_i}{V_1^2} =$$

$$B_m = \sqrt{\left(Y_0^2 - G_i^2\right)} =$$

$$Z_{eq} = \frac{V_{sc}}{I_{sc}} =$$

$$R_{eq} = \frac{P_{sc}}{I_{sc}^2} =$$

$$X_{eq} = \sqrt{\left(Z_{eq}^2 - R_{eq}^2\right)} =$$

a) Efficiency vs. Load characteristic at 0.8 power factor lag

Table 1.1

Serial No.	1	2	3	4	5	6	7	8
Different transformer Loading (K)	0.15	0.30	0.45	0.6	0.75	0.90	1.05	1.20
Copper loss ($K^2.P_{SC}$) in kW								
Iron loss (P_i) in kW								
Total loss(P_L) = ($P_i + K^2.P_{SC}$) in kW								
Output Power (P_{out}) in kW = K.(Rated kVA).cos θ								
Input Power (P_{in}) in kW = $P_{out} + P_L$								
Estimated Efficiency $\eta = \frac{Pout}{Pin}$								

b) Sample calculations:

Loading, k =

Output power, P_{out} = k.(Rated kVA).cos θ = k.(Rated kVA).(0.80) =

Iron loss (constant loss) = P_i =

Copper loss = $k^2.P_{SC}$ =

Total loss, $P_L = (P_i + k^2.P_{SC})$ =

Input Power, $P_{in} = P_{out} + P_L$ =

% Efficiency, $\eta = \frac{\text{Pout}}{\text{Pin}}$ X 100=

c) Maximum Efficiency

Loading at which maximum efficiency occurs, $k_{\max} = \sqrt{\frac{P_i}{P_{SC}}} =$

Maximum efficiency, $\eta_{\max} = \left(\frac{k_{\max}\,(\text{Rated kVA})\cos\theta}{k_{\max}\,(\text{Rated kVA})\cos\theta + 2P_i} \right)$

η_{max} at 0.8 power factor (lagging/leading) =

η_{max} at unity power factor =

d) Regulation vs. Power factor

Determine the following on HV side

Rated voltage V = , Rated current I =

R_{eq} = , X_{eq} =

Regulation (for lagging power factor) = I(R_{eq} cos θ + X_{eq} sin θ) / V

Regulation (for leading power factor) = I(R_{eq} cos θ - X_{eq} sin θ) / V

Table 1.2

Power factor, $\cos\theta$	0.2 leading	0.4 Leading	0.6 leading	0.8 leading	1.0	0.8 lagging	0.6 lagging	0.4 lagging	0.2 lagging
$R_{eq}\cos\theta$									
$X_{eq}\sin\theta$									
Regulation									

Mark the power factor corresponding to zero voltage regulation.

7. GRAPHS:

Draw: (a) Estimated Efficiency vs. output, at 0.8 power factor lag and unity power factor.

(b) Estimated Regulation vs. power factor.

8. RESULTS:

a. Load Efficiency

$\frac{1}{4}FL$ _________

$\frac{1}{2}FL$ _________

$\frac{3}{4}FL$ _________

FL _________

b. Maximum efficiency =

Load at which maximum efficiency occurs =

c. Power factor at which regulation is zero =

EXPERIMENT No. 2

LOAD TEST ON A DC SHUNT GENERATOR

Name____ ID No.________________________

Sec.No ________________________ Batch No.______________ Marks obtained______________

Date___________________________ Instructor's signature______________________________

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1. Objective

To obtain external characteristic of a DC shunt generator.

3. Name plate ratings:

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4. Range of instruments and accessories (standard format)

S.No.	DESCRIPTION	TYPE	RANGE	MFR. NAME	MFR. NO.

1. Connection Diagram

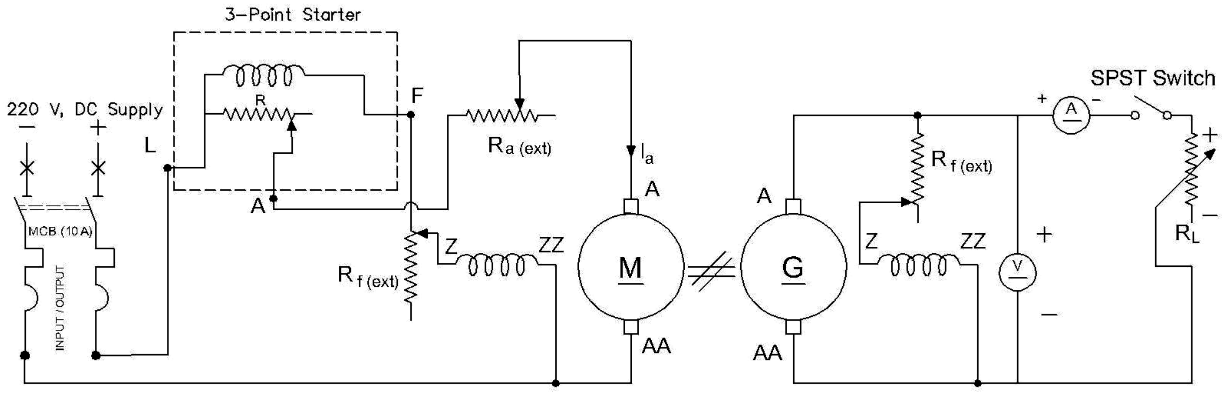

Fig.2.1

6. Readings:

Generator field resistance =

No-load speed, n_0 = (to be kept constant)

No-load voltage, V_0 =

Table 2.1

V_L									
I_L									

7. Graph

(1) V_L vs. I_L

9. Results

EXPERIMENT No. 3

OC AND SC TESTS ON A SYNCHRONOUS MACHINE

Name____ ID No.________________________

Sec.No _________________________ Batch No._____________ Marks obtained_____________

Date___________________________ Instructor's signature______________________________

1. Objective:

To determine the equivalent circuit parameters of a synchronous machine and hence to estimate the percentage regulation at different power factors.

2. Name plate ratings:

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4. Range of instruments and accessories (standard format)

S.No.	DESCRIPTION	TYPE	RANGE	MFR. NAME	MFR. NO.

5. Connection Diagram

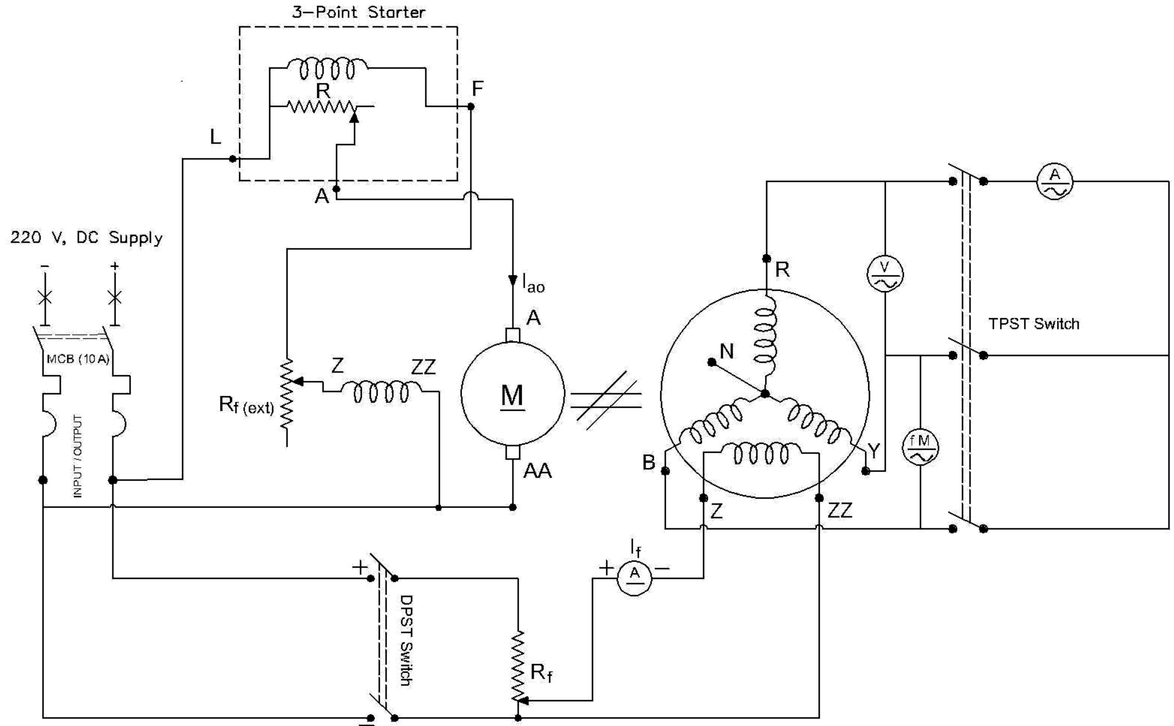

Fig.3.2 Connection diagram for conducting O.C. and S.C. test.

6. Readings

OC Test

Table 3.1 (O.C.C.)

I_f (A)								
V_{OCL} (line) (V)								
V_{OC} (phase) (V)								

SC Test

Table 3.2

I_f (A)					
I_{SC} (A)					

Armature Resistance

7. Calculations & Results (all calculations are done on per phase basis)

Calculate Z_s for all values of I_f. Plot Z_s against I_f. Comment on the variation of Z_s and explain reasons for the same.

I_f										
Z_s										

1. $Z_s(unsaturated) = \left.\left(\frac{V_{OC}}{I_{SC}}\right)\right|_{I_f = \text{constant}} =$

2. $Z_s(adjusted) = \left.\left(\frac{V_{OC}(rated)}{I_{SC}}\right)\right|_{I_f \text{ corresponding to } V_{OC} \text{ (rated value)}} =$

$X_s(adjusted) = \sqrt{\left(Z_s(adj)^2 - R_e^2\right)} =$

Observe that in your calculation of X_s (adj), effect of R_e (phase) can be ignored so that $X_s(adj) = Z_s(adj)$

1) Calculate the percentage regulation at full load 0.8 power factor lag/ lead and unity power factor for synchronous generator.

8. Graphs: O O.C.C., S.C.C. and Z_S vs. I_f.

9. Results

Percentage regulation at upf =

at 0.8 pf lag =

at 0.8 pf lead =

EXPERIMENT NO.4

MEASUREMENT OF POWER IN THREE-PHASE CIRCUIT

Name____ ID No.______________________

Sec.No ________________________ Batch No.____________ Marks obtained____________

Date___________________________ Instructor's signature_____________________________

1. Objective

To measure the active power, reactive power, apparent power & power factor in the three phase circuit by two-wattmeter method.

2. Name plate ratings:

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4. Range of instruments and accessories (standard format)

S.No.	DESCRIPTION	TYPE	RANGE	MFR. NAME	MFR. NO.

5. Connection diagram

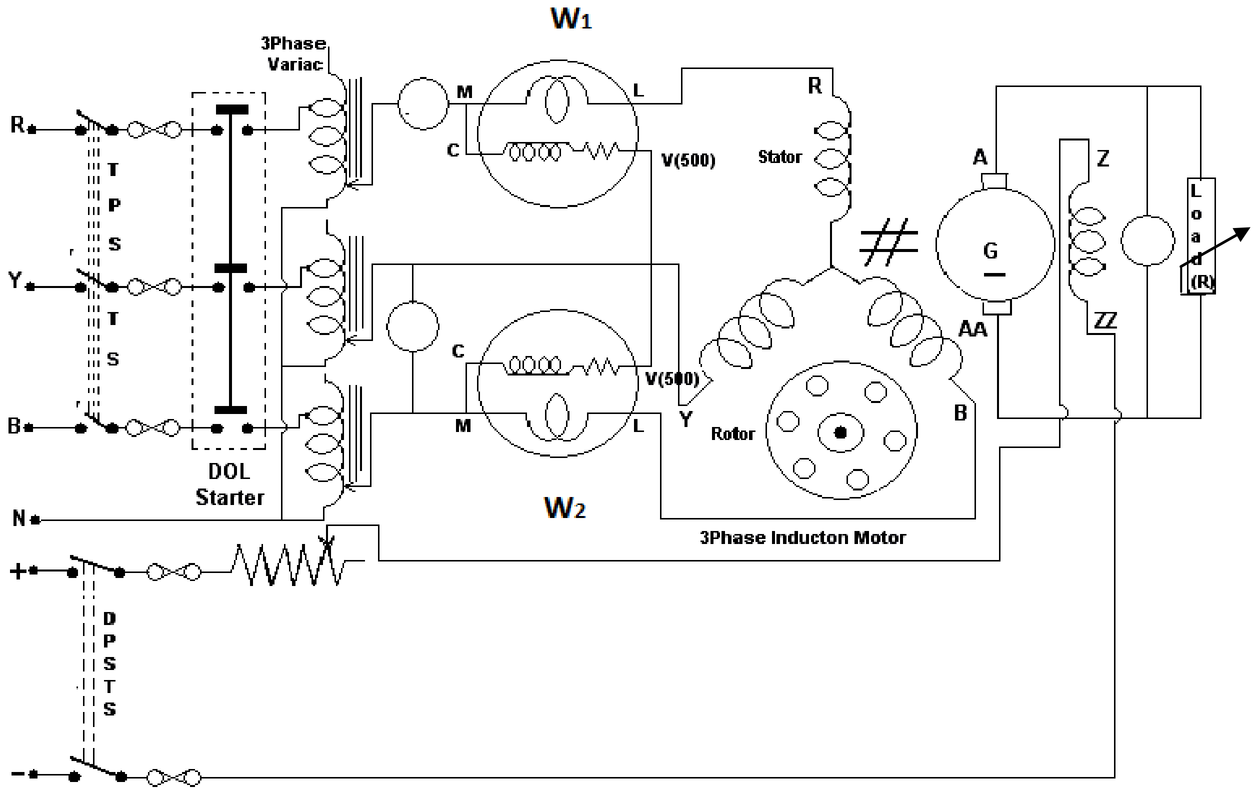

Fig 4.1: Power measurement by using two-wattmeter method

6. Readings

$$\text{Multiplication Factor (MF) of Wattmeter (WM)} = \frac{(\text{P.C. range} \times \text{C. C. range} \times \text{pf})}{(\text{Total no. of divisions on the scale})}$$

1. Multiplication factor (M.F.) of W1 =________________

2. Multiplication factor(M.F.) of W2 =_________________

7. Observations:

Table 4.1

S.NO	Wattmeter1 ×MF (W_1) Watts	Wattmeter2 ×MF (W_2) Watts	Ammeter (I_L) Amps	Voltmeter (V_L) Volts	Active Power (KW)	Reactive Power (KVAR)	Apparent Power (KVA)	Power Factor CosΦ
Load 0								
Load I								
Load II								
Load III								
Load IV								
Load V								

8. Calculations

1. Reading of wattmeter 1
   W_1 = No. of Div.× M.F. = ____________________
2. Reading of wattmeter '2'
   W_2 =No. of Div.× M.F. = _____________________
3. Active power in three phase load;
   $P = W_1 + W_2 =$ ______________
4. Reactive power in three phase load;
   $Q=\sqrt{3}\,(W_2 - W_1)$ Vars = _____________________
5. Apparent power in three phase load
   $S= \sqrt{P^2 + Q^2}$
6. Power factor of the load
   p.f. $=\cos(\tan^{-1}(Q/P)) =$_____________________

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9. Results