LABORATORY MANUAL

Electrical Machines and Applications Laboratory

Department of Instrumentation Engineering
JORHAT ENGINEERING COLLEGE
Assam-785007

Do’s

- Be punctual, maintain discipline & silence.
- Keep the Laboratory clean and tidy.
- Leave your shoes in the rack outside.
- Handle the equipments carefully.
- Save all your files properly.
- Come prepared with programs/algorithms/related manuals.
- Follow the procedure that has been instructed.
- Get the signature on experiment result sheet daily.
- For any clarification contact faculty/staff in charge only.
- Log off the system properly before switching off .

Don’ts

- Avoid unnecessary chat or walk.
- Disfiguring of furniture is prohibited.
- Avoid using cell phones unless absolutely necessary.
- Do not use personal pen drives without permission.
- Do not displace monitor, keyboard, mouse etc.
- Avoid late submission of laboratory reports.

IN408	EMA LABORATORY	Semester IV	L-T-P 0-0-2	1 CREDIT

Experiment No.	Title of the Experiment	Objective of the Experiment
1	Open circuit characteristics of a DC generator	To draw the open CIRCUIT CHARACTRISTICS (OCC) or magnetization characteristic and to determine the critical field resistance and the critical speed of a DC shunt generator.
2	Load test on a shunt generator	To determine the external and internal characteristic of a DC shunt generator.
3	Characteristic of a dc shunt generator	To determine the external and internal characteristic of a DC series generator.
4	Speed control of a dc shunt motor I.	To control the speed of a DC shunt motor by the method of a. Armature control and b. Flux control or field control c.
5	Open circuit test and short circuir test on a single phase transformer	To perform open circuit test and short circuit test on a single phase transformer and to calculate the parameters of the equivalent circuit. Also to estimate the efficiency and regulation of the transformer for the full range of loading.
6	Polarity test and load test on a single phase transformer	To perform polarity test on a single phase transformer also to estimate the efficiency and regulation of the transformer for the full range of loading.
7	Regulation of an alternator	To perform the open-circuit and short-circuit tests on a three phase alternator and to determine the regulation by synchronous impedance method
8	Measurement of power in three phase circuit by two wattmeter method	To measure the power and power factor in a three phase balanced circuit by two wattmeter.

Text book

- Electrical Machines, D P Kothari and R J Nagrath

Student Profile

Name	
Roll Number	
Department	
Year	

Student Performance

Sl. No.	Title of the Experiment	Remarks
1	Open circuit charactristics of a DC generator	
2	Load test on a shunt generator	
3	Characteristic of a dc shunt generator	
4	Speed control of a dc shunt motor	
5	Open circuit test and short circuir test on a single phase transformer	
6	Polarity test and load test on a single phase transformer	
7	Regulation of an alternator	
8	Measurement of power in three phase circuit by two wattmeter method	

Office Use

Checked and found

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Grade/ Marks

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Signature

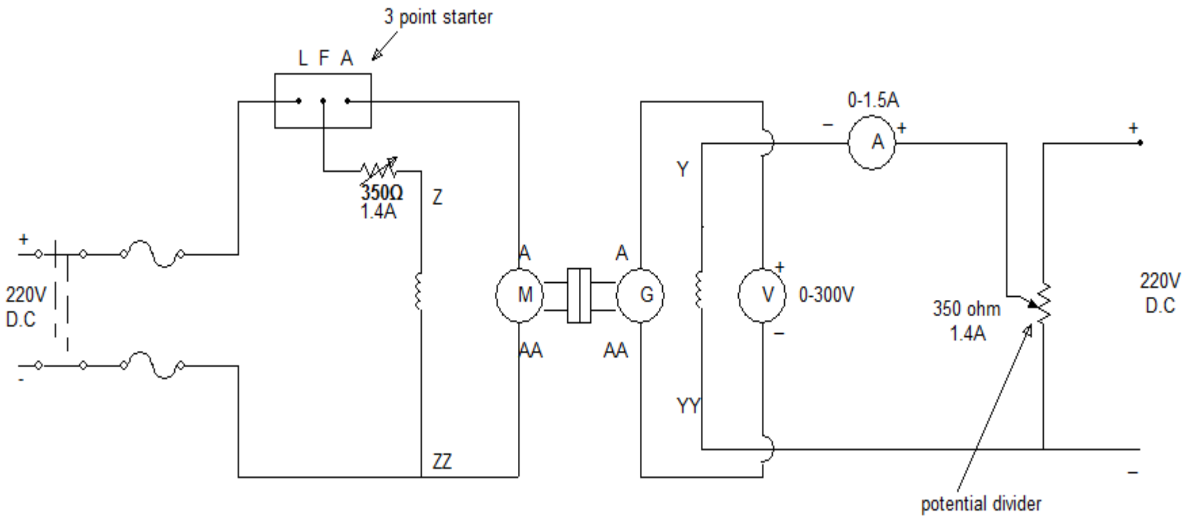
……………………………………………………

Experiment No: 1

TITLE: OPEN CIRCUIT CHARACTRISTICS OF A DC GENERATOR

OBJECT: To draw the open CIRCUIT CHARACTRISTICS (OCC) or magnetization characteristic and to determine the critical field resistance and the critical speed of a DC shunt generator.

CIRCUIT DIAGRAM:



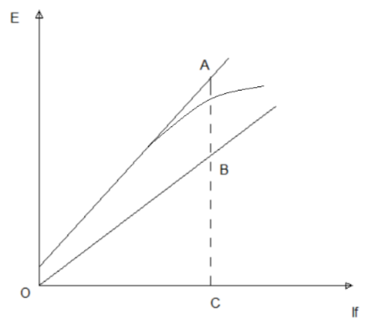
LIST OF APPARATUS:

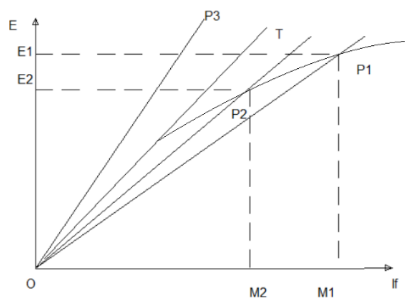
SL No	Item	Range	Maker	Makers No

MACHINE SPECIFICATIONS:

THEORY: The open circuit characteristic or the magnetization characteristic of the DC generator gives the relationship between flux per pole and exciting current or the field m.m.f. per pole. If the machine is run at constant speed on no load, the induced e.m.f. is proportional to the flux per pole (and hence the field current); if e.m.f. is plotted against the exciting current the graph is nearly called the open-circuit characteristic. In a DC generator, the induced e.m.f. is given as $E_g=\frac{\Phi ZNP}{60A}$ volt. Hence if speed N is constant, $E_g=k\Phi$. It is obvious that when the field current, I_f is increased from its initial value, the flux and hence the generated e.m.f. E_g increases directly as I_f while the poles are unsaturated. But as the flux density increases, the poles become saturated, so a greater increase in I_f is required to produce a given increase in E_g than on the lower part of the curve , as shown. Also due to residual magnetism in the poles some e.m.f. is generated even when I_f is zero. Hence curve starts a little way up as shown. If the machine is on open circuit, the shunt circuit of the DC generator can be regarded as in series with the armature. A straight line is drawn through origin so as to cut the characteristic at P_1; then if E_1 is the induced e.m.f. and I_{sh} shunt current, $P_1M_1=E_1$, $O_1M_1=I_{sh}$

Therefore, $\tan\alpha_1=\frac{\mathrm{P1M1}}{\mathrm{O1M1}}=\frac{\mathrm{E1}}{\mathrm{Ish}}=R_{sh}$, the total resistance of the shunt circuit. Hence if we draw any straight line thro. The origin, such as OP_2 whose inclination,α_2 represents the shunt resistance then its ordinate P_2M_2 will give the induced e.m.f corresponding to that resistance and its abscissa OM_2 the shunt current. If the straight line OP_3 doesn't intersect the characteristic, the shunt resistance it represents is too great for the machine to be able to build up its field and function as generator. The slope α_3 of the tangent OT therefore represents the maximum allowable value of the shunt resistance, called the critical field resistance, R_c. The corresponding speed, called the critical speed, N_c is found by drawing the straight line OP_1 with a slope equal to the shunt field resistance R_c and measuring the lengths AC and BC giving $\frac{BC}{AC}=\frac{\mathrm{Nc}}{Full\ speed}$, or $N_c=\frac{BC}{AC}\times Full\ speed(Rated\ speed)$



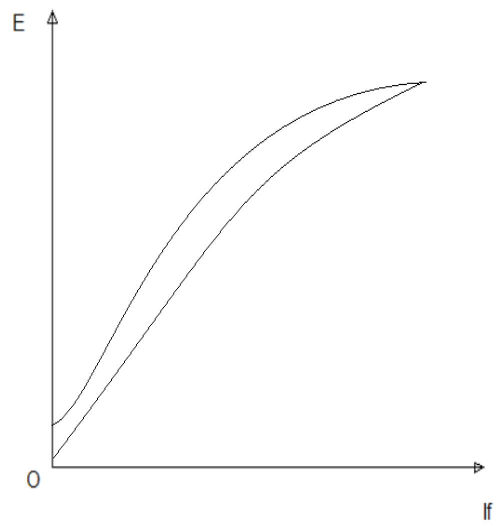


PROCEDURE:

1. Connect the circuit as shown in the diagram.
2. With the generator G field circuit OFF start the motor M with the help of the starter. Note the voltmeter reading and the speed of the machine. The machine may be run at rated speed by adjusting the field regulator of the motor. The voltmeter will indicate the voltage due to residual magnetism in the field of the generator (at I_f=0).
3. Adjust the output voltage potential divider at zero and then pt the supply on.(note that instead of using two DC supply the same supply in the motor

circuit may be used. But care should be taken to keep the output voltage of the potential divider at zero)

4. Increase the field current in regular steps, nothing at least ten sets of readings of voltage and field current, to about 125%of the rated voltage of the generator.(Note: while increasing the field current don't decrease it to obtain a reading of particular value).
5. Take readings for decreasing field current in the similar manner till I_f is zero.
6. Put the motor and generator supply OFF (P.S.: the speed of the machine should remain constant throughout the experiment.
7. Draw a smooth curve as shown.



OBSERVATION:

Increasing field current | Decreasing field current

SL. No.	I_f (Amps)	Induced Voltage (V)	Speed N (RPM)	SL. No.	I_f (Amps)	Induced Voltage (V)	Speed N (RPM)

- Plot OCC for both I_f increasing and decreasing. Determine R_c and N_c from OCC for increasing I_f only.
- Report:
  1. Plot the OCC curve and Determine R_c and N_c for rated speed.
  2. The curve for decreasing value of field current lies slightly above of the increasing value of I_f. Explain why?
  3. What do you mean by the term “Residual magnetism”?
  4. How will you determine he OCC at another speed N_2 from the OCC of a shunt generator running at speed N_1 and has shunt field resistance, R_{sh}?
  5. Why doesn’t the OCC starts from the origin?
  6. Define “critical speed” of a shunt generator.

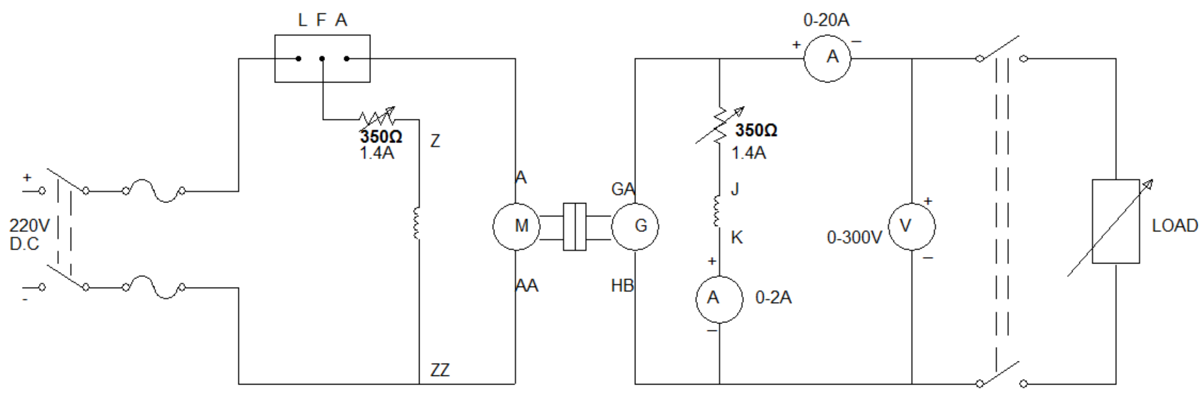
Signature of the teacher **Date**

Experiment No: 2

TITLE: **LOAD TEST ON A SHUNT GENERATOR**

OBJECT: **To determine the external and internal characteristic of a DC shunt generator.**

CIRCUIT DIAGRAM:



LIST OF APPARATUS:

SL No	Item	Range	Maker	Makers No

MACHINE SPECIFICATIONS:

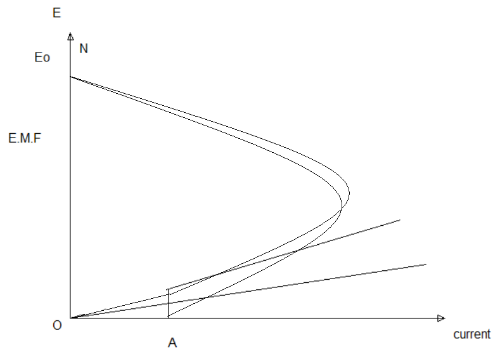
MOTOR:

GENERATOR:

THEORY: In a DC shunt generator, on no-load the terminal p.d. is equal to the no load induced e.m.f. E. When the armature delivers current, i.e. the generato is loaded:

a) The induced e.m.f. decreases because the armature reaction reduces the flux per pole.
b) V becomes less than E because of the voltage drop I_aR_a, where Ra is the total resistance of the armature circuit.

The graph of induced e.m.f. against armature current is the internal characteristic , and the graph of terminal voltage against load current is the external characteristic, or voltage characteristic .We see both the characteristic drop from no load point, N, the second more than the first, as shown. When the load current I_l progressively increased (by reducing the load resistance), at first the tendency of decreased resistance to increase the current is greater than the tendency of the armature reaction and the voltage drop to reduced terminal potential Difference and therefore, the current. Eventually a point will be reached at which these two effects neutralize each other. Beyond that second tendency will be predominate and the characteristic will turn back as shown.



The point A at which the external characteristic cuts the current axis corresponds to short circuit- a gradual short circuit. The internal characteristic stops short at B directly above A, and the distance AB gives the internal e.m.f. required to produce the short circuit current, OA. If a tangent OP is drawn to the internal characteristic the resistance represented by its slope gives the minimum external resistance for which the generator will excite if it has to build up its field with the load circuit closed. If the external resistance is less than represented by the slope of OP, it will fail to excite. <u>Thus the shunt generator has two critical resistances, one for the field circuit and other for the external circuit.</u>

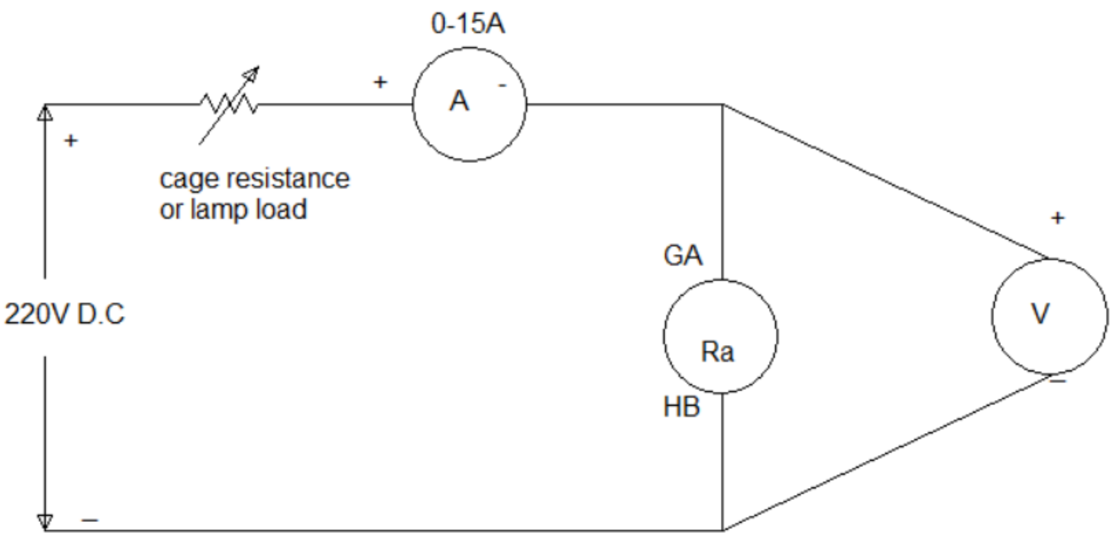
In a shunt generator, $I_a=I_l+I_f$, where, I_a is armature current, I_l is the load current and I_f shunt fiend current and $E_0=V_T+ I_aR_a$, E_0=induced e.m.f. in armature, V_T=Terminal voltage, R_a=armature winding resistance. Thus , once the external characteristic of the shunt generator is known, and after drawing the I_aR_a line , the internal characteristic can be determined. The value of R_a can be found out conventionally by the voltage drop method, as shown

PROCEDURE:

1. Connect the circuit as shown in the diagram.
2. Start the motor with the help of the starter and obtain the rated speed.
3. In the experiment, it is necessary to obtain the no load e.m.f. of the shunt generator which will give the rated voltage at rated load (see the specification on the name plate of the generator). This is achieved by

adjusting the field regulator so that the generator induced e.m.f. is well above the rated voltage and then actually loading is to its rated voltage at rated load current.

4. Once the step 3. Is obtained at rated speed of the generator, note down the meter readings and the speed of the generator
5. Reduce the load on the generator so as to obtain at least about 10 sets of readings
6. Switch off all the loads, reduce field current of the generator and then switch off the motor
7. Measure armature resistance R_a of the generator, or its value may be supplied.
8.



Measurement of Ra

NOTE: The loading on the generator may be as high as 120% of its full load capacity. The armature shaft must not rotate while measuring R_a.

OBSERVATIONS:

SL No	Load current I_l(amps)	Terminal voltage V_T(volts)	Field current I_f(amps)	Speed in (rpm)	Remarks

Prepare another experimental list of observations including E_0, I_a, I_aR_a in the above list for determining internal characteristic.

REPORTS:

1. Plot the external characteristic.
2. Deduce the internal characteristic from 1. And estimate the full load voltage drop due to armature reaction.
3. Is is possible to short circuit a shunt generator? Explain.
4. State some applications of a shunt generator.

*While measuring R_a, at least three sets of readings should be taken and the average of R_a b considered.

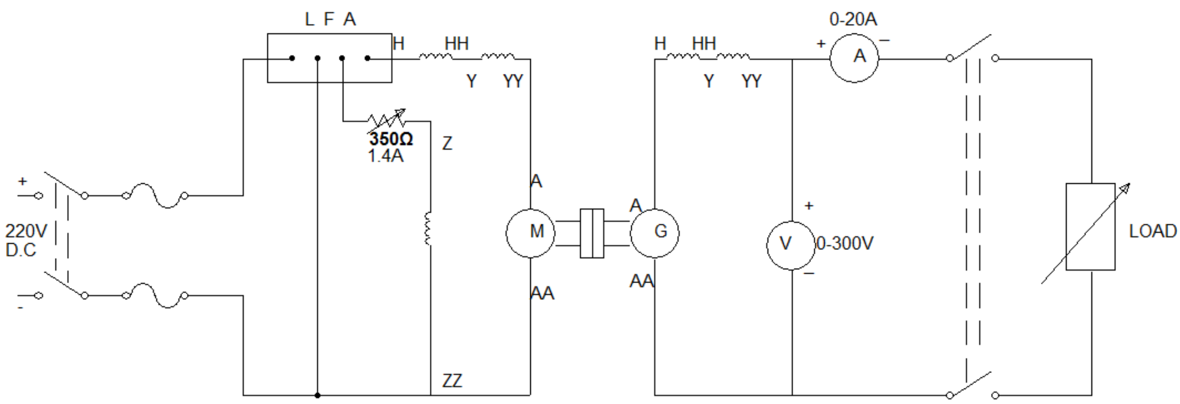
Signature of the teacher **Date**

Experiment No: 3

TITLE: **CHARACTERISTIC OF A DC SHUNT GENERATOR**

OBJECT: **To determine the external and internal characteristic of a DC series generator.**

CIRCUIT DIAGRAM:



LIST OF APPARATUS:

SL No	Item	Range	Maker	Makers No

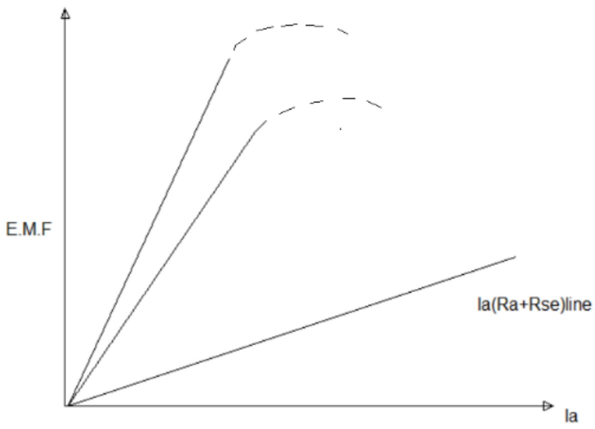
MACHINE SPECIFICATIONS:

MOTOR:

GENERATOR:

THEORY: A DC series generator is a self-exciting type of machine and it can do so only if the load circuit is closed. In the generator the induced or generated e.m.f. $E=k\Phi N=k^{/}I_a$, if N is constant. Terminal voltage, $V=E-I_a(R_a+R_{se})$, where R_a is armature resistance and R_{se}=series field resistance.

Therefore $V \sim K^{/}I_a$, provided R_a and R_{se} are small. Thus the relationship between V and I_a will exhibit a nearly linear relation at smaller load till the onset of armature reaction. The plot V vs I_a gives external characteristic and that between E and I_a gives the internal characteristic of the series generator. It will be noted that the generator has rising voltage characteristic, i.e. with increase in loads, voltage also increases. But at high loads, the voltage starts decreasing due to excessive demagnetizing effects of armature reaction. In fact external voltage starts decreasing as the load current is increased. The internal characteristic can be determined adding $I_a(R_a+R_{se})$ with the external characteristic.



PROCEDURES:

1. Connect the circuit as shown.
2. With generator load off start the motor with the help of the starter and bring it to rated speed by adjusting its field regulator (the motor given is a compound motor).
3. Put the generator load on and increase it gradually. Note down all the meter readings. Take at least 10 sets of readings.
4. Gradually put off the load on the generator and note down about 10 sets of reading for decreasing current.
5. Switch of the motor supply.
6. Measure the combined resistance of the armature, series pole and interpoles (if any) by voltage drop method. (Refer load test on shunt generator), or the value may be supplied.

OBSERVATIONS:

Rated speed, N =

R_a+R_{sc}=

Increasing load   Decreasing load

SL. No	Terminal voltage V,(volts)	Load current (amps)	SL. No	Terminal voltage V,(volts)	Load current (amps)

Prepare another chart showing E,V,I_a etc. to draw the external and internal characteristics of the generator. Consider I_a=I_l for decreasing values

REPORT:

1. Explain how will you obtain the external characteristic curve from the open circuit characteristic if the machine is

    a) Adequately compensated
    b) Uncompensated

2. State some applications of DC shunt generator and motor

Signature of the teacher   **Date**

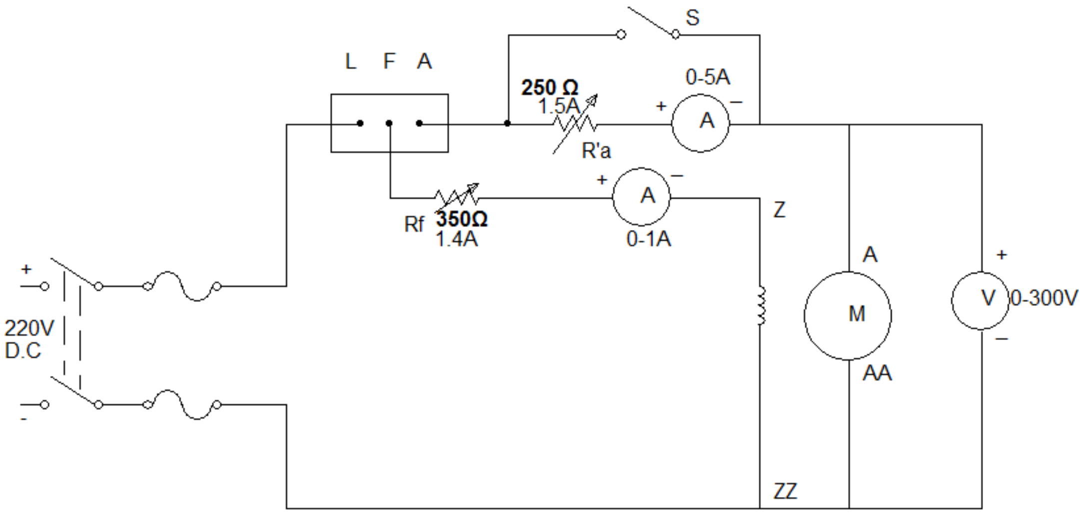
Experiment No: 4

TITLE: **SPEED CONTROL OF A DC SHUNT MOTOR**

OBJECT: **To control the speed of a DC shunt motor by the method of**

I. **Armature control and**
II. **Flux control or field control**

CIRCUIT DIAGRAM:



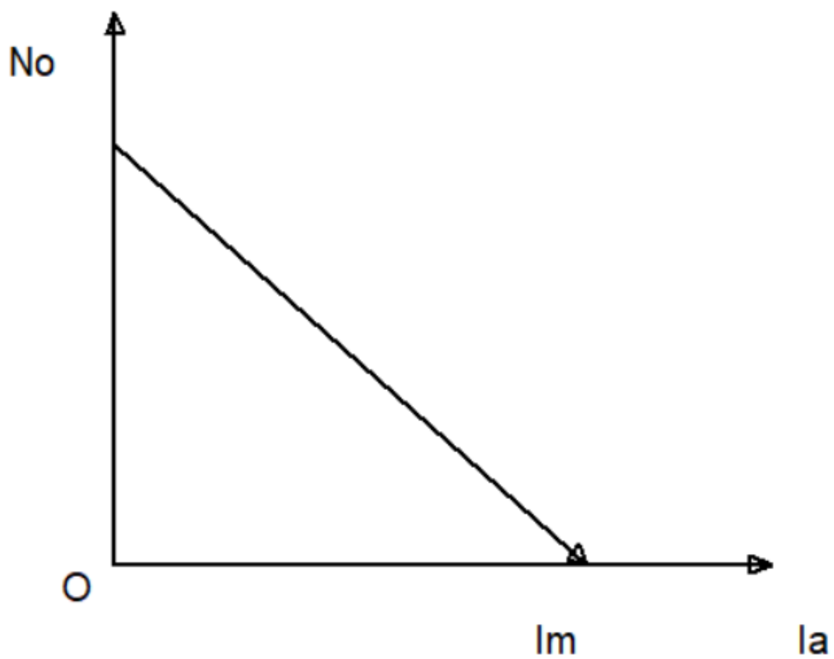
LIST OF APPARATUS:

SL No	Item	Range	Maker	Makers No

MACHINE SPECIFICATIONS:

THEORY:

1. Let an adjustable resistance $R_a^{/}$ be placed in series with the armature of the shunt motor, making the total resistance in the armature circuit (R_a+ $R_a^{/}$), where R_a is the resistance of the armature winding; then the back e.m.f. for any armature current I_a is given by E_b=V-(R_a+ R'_a)I_a. at no load, and no series resistance, $R_a^{/}$,in circuit, the back e.m.f. is approximately equal to the applied voltage. Since, for constant excitation, the speed is proportional to the back e.m.f., we have denoting no load speed by N_0,$\frac{N}{\mathrm{N0}} = \frac{\mathrm{V-(Ra+ R/a)Ia}}{\mathrm{V}}$ therefore
   Now putting R_a+ $R_a^{/}$= R_t; then N=N_0(1 - $\frac{\mathrm{RtIa}}{\mathrm{V}}$)
   For a given resistance R_t, the speed N, is thus a linear function of the armature current I_a, the graph of N vs. I_a being a dropping straight line, as shown. The amount of drop is obviously depends upon R_t, and therefore upon R'_a graph of family of speed/current curves can be drawn. In the graph, I_m=V/R_t



*This method is used when speeds below the no-load speed or rated speed are required

2. For a DC motor the back e.m.f. E_b=(ΦZN/60)P/A , where ,Φ=flux per pole; Z=no of armature conductors; N=speed; P=no of poles and A=no of parallel path in the armature winding.
   If V=Supply voltage, then resulting e.m.f. acting in the armature circuit is $V-E_b=V-(\Phi ZN/60)P/A$; Armature current, $I_a=(V-E_b)/R_a$ or $I_a=\frac{V-(\Phi ZN/60)P/A}{Ra}$ and the speed is $N=\frac{V-IaRa(60A/P)}{Z}$ N=speed in r.p.m. since I_aR_a is small compared to V and Φ,Z,A and P are all constants for a given motor.
   N ∞ 1/ Φ so long as V constant.
   Thus the speed of a DC motor is inversely proportional to the flux/pole, i.e. the field current I_f. The field current may be varied by means of a resistance (R_f) put the field current in series.

**This method of speed control of the shunt motor gives speed greater than normal speed, i.e. above the rated speed.

PROCEDURES:

a) Armature control method:
   1. Connect the circuit as shown.
   2. With switch S closed, R'_a and R_f in their minimum position , switch on the supply and start the motor by means of the three point starter.
   3. As the motor speeds up open the switch S and note down the various meter readings. The resistance R_f may be adjusted partially so that the motor runs at rated speed.
   4. Increase R'_a insteps and note down the various instrument readings and the speed
   5. Repeat step 4. To note down about 10 sets of reading.
   6. Adjust R'_a such that the motor just stalls.
   7. Switch off the supply.

b) Flux or field control method
   1. Closed the switch off.
   2. Make R'_a and R_f in their minimum position , switch on the supply and start the motor as before

3. Cut out the field regulator R_f in steps and note down speed N and the field current (I_f). The other meters will indicate more or less same readings.
4. Repeat step 3. To note down about 10 sets of readings, till speed is 10-15% more than the rated value.
5. Bring R_f to its minimum position, switch off the supply.

OBSERVATIONS:

Armature control, I_f (constant)=				Field control, Supply voltage (constant)=			
SL NO	Armature voltage (volts)	Armature current (amps)	Speed (RPM)	SL NO	Armature voltage (volts)	Armature current (amps)	Speed (RPM)

REPORT:

1. Plot the graphs N vs. V_a (armature voltage) and N vs. I_f (field current) from result obtained. Compare on your results.
2. States the merits and demerits of these methods.
3. Write in details about the voltage control method (Ward-Leonard method) for controlling the speed of a shunt motor.

Signature of the teacher **Date**

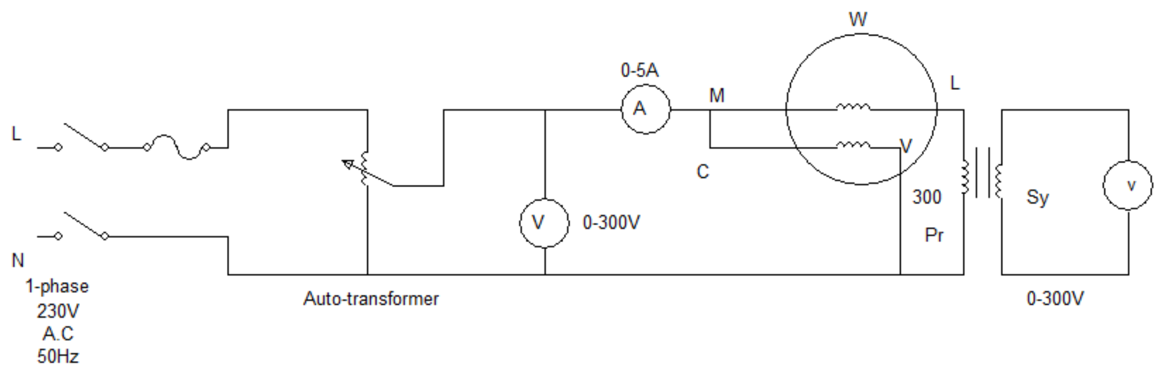
Experiment No: 5

TITLE: **OPEN CIRCUIT TEST AND SHORT CIRCUIR TEST ON A SINGLE PHASE TRANSFORMER**

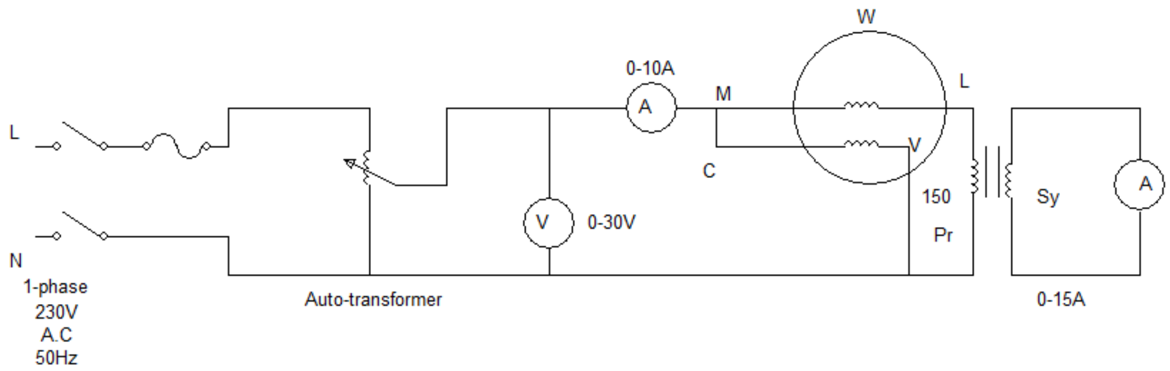
OBJECT: **To perform open circuit test and short circuir test on a single phase transformer and to calculate the parameters of the equivalent circuit. Also to estimate the efficiency and regulation of the transformer for the full range of loading.**

CIRCUIT DIAGRAM:

OPEN CIRCUIT TEST:-



SHORT CIRCUIT TEST:-

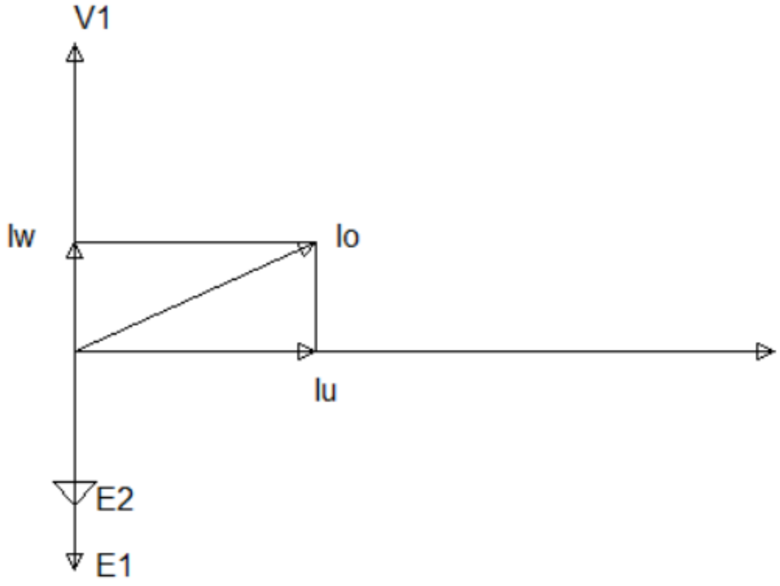


LIST OF APPARATUS:

SL No	Item	Range	Maker	Makers No

TRANSFORMER SPECIFICATIONS:

THEORY: The purpose of the open circuit or the no-load test on a transformer is to determine the no load losses or the core loss (or iron loss comprising the hysteresis and the eddy current losses) and the no load primary current (I_0) which is helpful in finding the components representing the core loss conductance G_0 (or resistance R_0) and magnetizing suceptance B_0 (or reactance X_0). One winding of the transformer left open and the other is connected to its supply of normal voltage and frequency. The primary current I_o has two components, first one is a magnetizing component I_μ lagging behind V_1 by 90^0 and the second one is a working component I_ω, producing the iron loss of the transformer and in phase with V_1. The no load vector diagram is shown. If W_0 is the wattmeter reading (refer diagram for OC test), then,



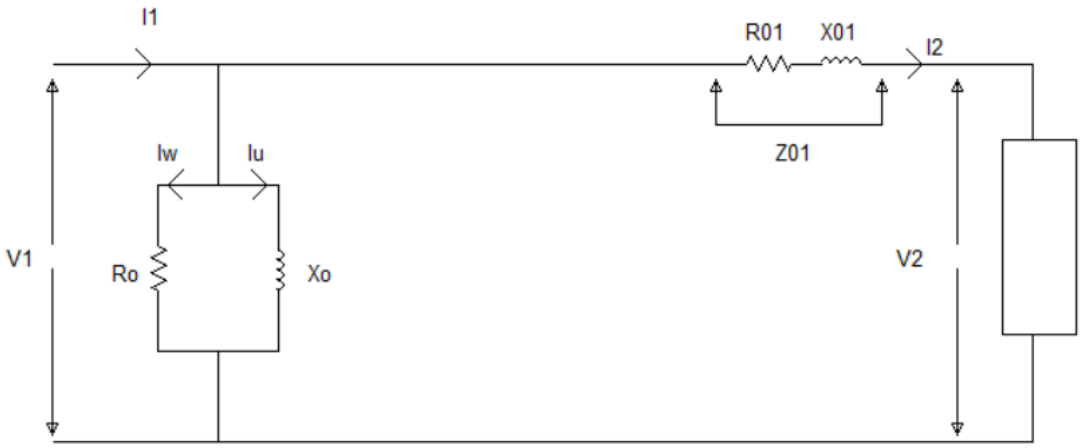
$W_0=V_1I_0\cos\Phi_0$, $\cos\Phi_0= W_0/V_1I_0$

$I_\mu=I_0 \sin\Phi_0$, $I_W= I_0 \cos\Phi_0$, $X_0=V_1/I_\mu$, $R_0=V_1/I_w$

The purpose of the short circuit test or impedance test on a transformer is to determine-

I. Eqvt. Impedance (Z_{01} or Z_{02}), leakage reactance, (X_{01} orX_{02}) and total resistance (R_{01} or R_{02}) of the transformer as referred to the winding in which the meters are placed
II. Full load copper loss (or loss at any other load) to be used for calculating efficiency of the transformer
III. Having known Z_{01} or Z_{02}, the total voltage drop in the transformer as referred to the primary or secondary side, which is used to calculate the regulation of the transformer. In this test, a reduced voltage is applied on the primary so as to calculate full load current in the secondary. As the core loss is very small (flux being small). The transformer (refer diagram for SC test) represents the full load copper loss of the transformer , V_{sc} the voltage required to calculate rated load current, I_1 primary current and W= wattmeter reading during short circuit, then
$Z_{01}=V_{sc}/I_1$, Also $W=I_1^2R_{01}$ or $R_{01}=W/I_1^2$ and $X_{01}=\sqrt{(Z_{01}^2- R_{01}^2)}$

The equivalent circuit:



Efficiency of a transformer, η=Output/(Output + Cu loss + Iron loss(constant)) X 100%, Also $\eta = (V_1 I_1 \cos\Phi_1 - I_1^2 R_{01} - W_1)/ V_1 I_1 \cos\Phi_1)$ X100%, so that η at any load and power factor can be calculated.

For η_{max}, variable copper loss= Iron loss (constant)

Regulation of a transformer

% Regulation = $((V_{02} - V_2)/ V_{02})$ X 100%

V_{02}= Secondary voltage at no load

V_2= Secondary voltage at full load

It can be shown as

% Regulation= $((I_1 R_{01} \cos\Phi \; +\!- \; I_1 R_{01} \sin\Phi)/V_1)$ X 100%, in terms of primary values "+" for lagging power factor and "-"for leading power factor.

Thus regulation of the transformer at any load and power factor can be calculated.

PROCEDURE:- (O.C.TEST):

i. Connect the circuit as sown.
ii. Put on the supply with 0 applied voltage to the primary of the transformer
iii. Increase the voltage by means of auto transformer p to the rated voltage of the voltage
iv. Note down the instrument readings.
v. Decrease voltage and switch off the supply.

OBSERVATION:

Multiplying factor or watt meter constant,

K= ((Rated voltage) X (Rated current))/ (No of scale divisions), Watts/div

=

SL No	Primary Voltage V_1(volts)	Primary (no-load) current, I_0(amps)	W-meter Readings (divisions)	W-meter Readings (watts)	Secondary Voltage V_2(volts)

PROCEDURE: (S.C.TEST):

i. Connect the circuit as shown.
ii. Put on the supply with 0 applied voltage to the primary of the transformer
iii. Increase the primary voltage slowly and carefully so as to obtain full load current in the shorted secondary winding (through the ammeter)
iv. Note down the instrument readings.
v. Decrease voltage and switch off the supply.

OBSERVATION:

K=

SL No	Primary Voltage V_1(volts)	Primary (no-load) current, I_0(amps)	W-meter Readings (divisions)	W-meter Readings (watts)	Secondary current I_2(amps)

REPORT:

i. Draw the equivalent circuit and calculate all the parameters of the transformer from this two tests
ii. Determine the efficiency and regulations of the transformer at $^{1/4}$th, $^{1/2}$th, $^{3/4th}$ and full load at .8 (lagging) , .8 (leading) and unity power factor of the load.
iii. Determine the maximum efficiency of the transformer

Signature of the teacher **Date**

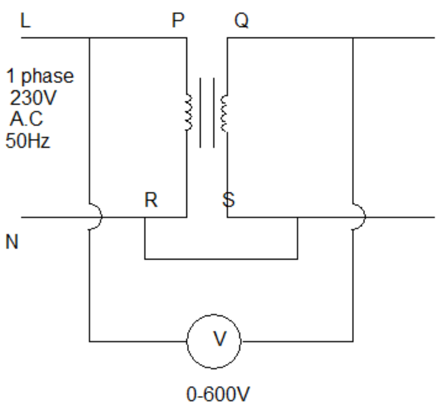
Experiment No: 6

TITLE: POLARITY TEST AND LOAD TEST ON A SINGLE PHASE TRANSFORMER

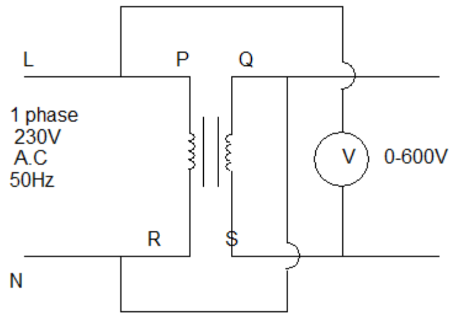
OBJECT: **To perform polarity test on a single phase transformer .Also to estimate the efficiency and regulation of the transformer for the full range of loading.**

CIRCUIT DIAGRAM:

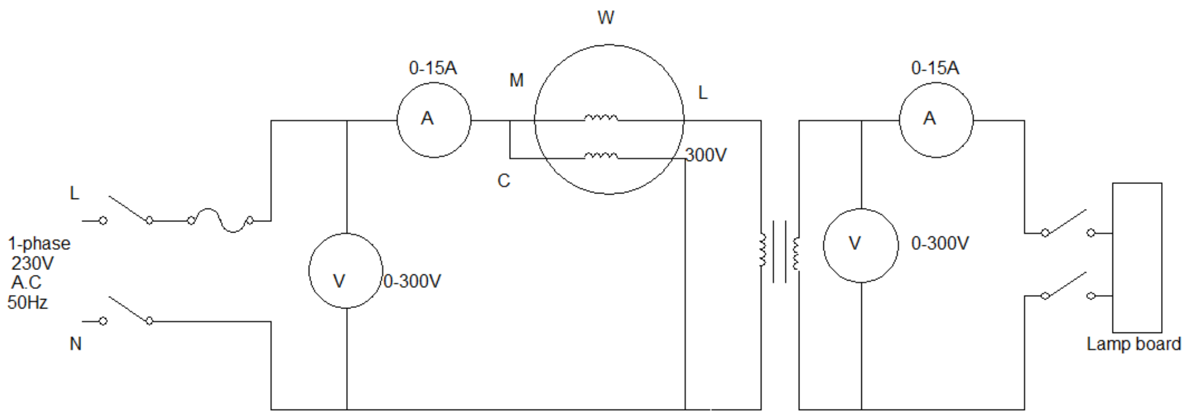
POLARITY TEST:



(a)



(b)



Theroy: When a transformer (single phase or three phase) is connected with an ac voltage, its terminals develop instantaneous polarities either positive or negative. For parallel operations of transformers it is a must that terminals of the secondary side with identical polarities can only be grouped together. If the secondary terminals with opposite polarities are joined together then a local circuit among secondary windings will be formed causing a condition of short circuits. Thus, before paralleling a bank of transformers, he polarity test must be carried out.

The efficiency and the regulation of the transformer can be determined by actually loading it to full capacity.

% Efficiency=(Output/ Input)X100%

The output of the transformer can be read by means of a voltmeter and a ammeter (V X 1), if the load is resistive. For inductive and capacitive load, a wattmeter may be used

% Regulation=((V_{02} – V_2)/ V_{02}) X 100%

V_{02}= Secondary voltage at no load

V_2= Secondary voltage at full load

Thus regulation of a transformer is the percentage difference between no load a full load secondary voltages at a given power factor of the load. The secondary terminal voltage V falls due to increase in load that causes an increase in drop in the secondary winding impedance.

PROCEDURE: POLARITY TEST:

Instead of using several voltmeters for the purpose a single voltmeter can be used and the voltage across the terminals (P, Q, R and S) can be tapped.

i. Switch on the supply and measure the supply voltage , the secondary voltage and the voltage across P and Q (Fig a).

ii. Similarly measure the voltage across P and S (Fig b) after joining the appropriate terminals.

OBSERVATIONS: POLARITY TEST:

Type of connection	Voltmeter reading(volts)	Inference
Fig (a)		
Fig (b)		

PROCEDURE: LOAD TEST:

i. Connect the circuit as shown
ii. Switch on the supply and note the meter readings
iii. Increase the load gradually in steps and note down the corresponding meter readings
iv. Repeat the procedure for around five different sets around no load , half load and full load
v. Switch off the load and supply.

Sl No	Primary Voltage, V (volts)	Primary Current, I (amps)	W-meter Reading (Divisions)	W-meter Reading (watt)	Sy voltage, (volts)	Sy current (amps)	% Effecy	% Regn

Multiplying factor or wattmeter constant,

K= ((Rated voltage) X (Rated current))/ (No of scale divisions), watts/div

$\cos \Phi =$

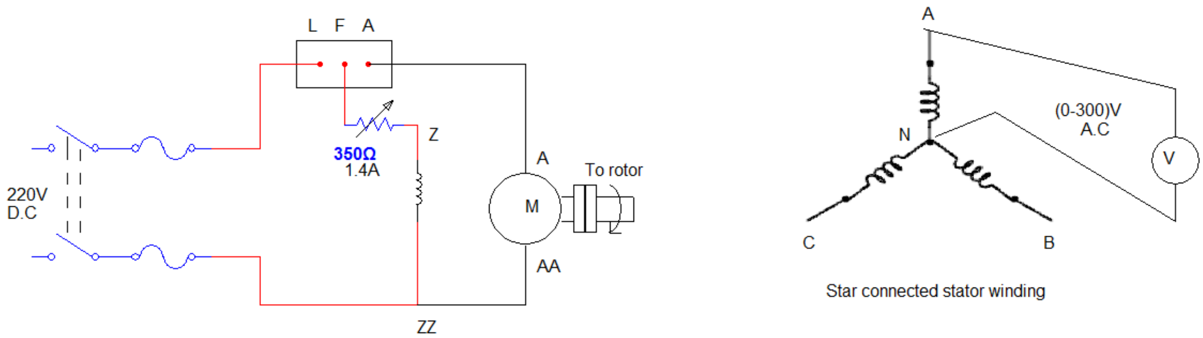
Signature of the teacher **Date**

Experiment No: 7

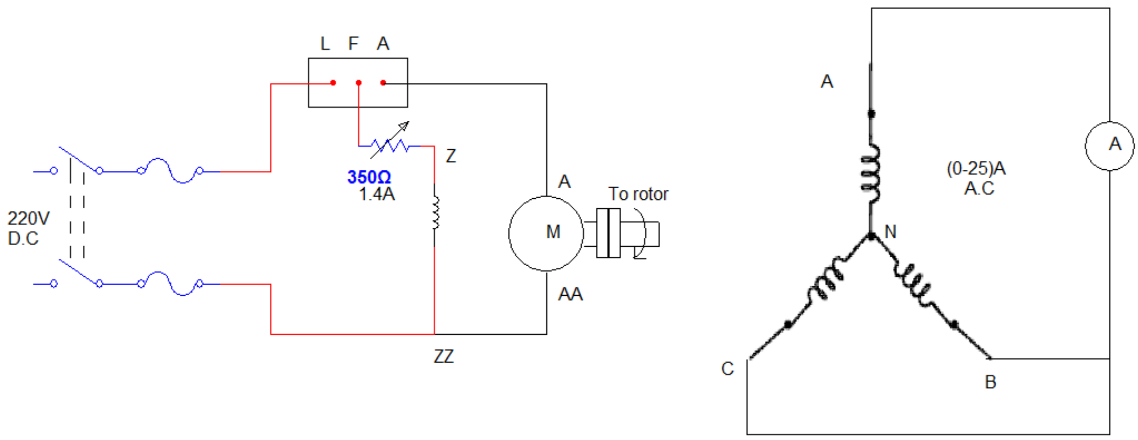
TITLE: REGULATION OF AN ALTERNATOR

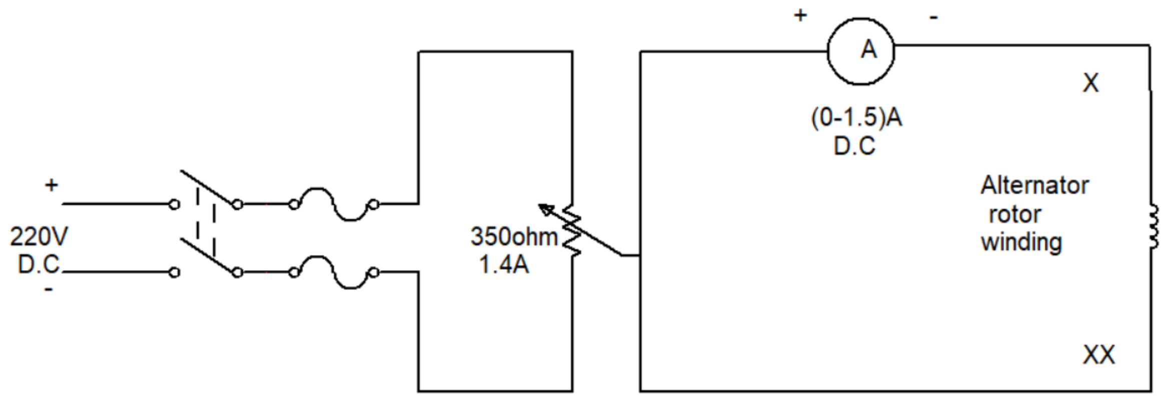
OBJECT: To perform the open-circuit and short-circuit tests on a three phase alternator and to determine the regulation by synchronous impedance method

CIRCUIT DIAGRAM:



Open circuit test





LIST OF APPARATUS:

SL No	Item	Range	Maker	Makers No

MACHINE SPECIFICATIONS:

THEORY:

The regulation of an alternator is the percentage difference from no load to full load voltage when the load is suddenly thrown off, the machine being delivering the load at a giver power factor and rated speed, i.e.

% Regulation= $((|E_0|)-|V|)/(|V|))$X100%

The synchronous impedance method of determining the regulation involves the following steps;

i. The open circuit characteristic is to be plotted form the test.
ii. The short circuit characteristic is to be plotted from the test. This characteristic is a straight line passing through the origin. The characteristics are shown below.

PROCEDURE: (O.C. TEST):

i. Connect the circuit as shown.
ii. Keep the output voltage for supplying the rotor d.c. field at zero. Start the motor (M) with the help of the starter keeping the field regulator of the motor at its minimum position.
iii. Adjust the field regulator so as to obtain the rated speed of the alternator and measure the speed by a tachometer.
iv. Increase the rotor field current gradually and note down the alternator induced e.m.f. and the rotor field current. Take about ten sets of readings….
v. Decrease the field current to zero and switch off the supplies to the motor and rotor

(N.B.: D.C. supply used for running the motor (M) may be used to supply the rotor field also. But care must be taken so that the output of the potential divider is initial at zero position)

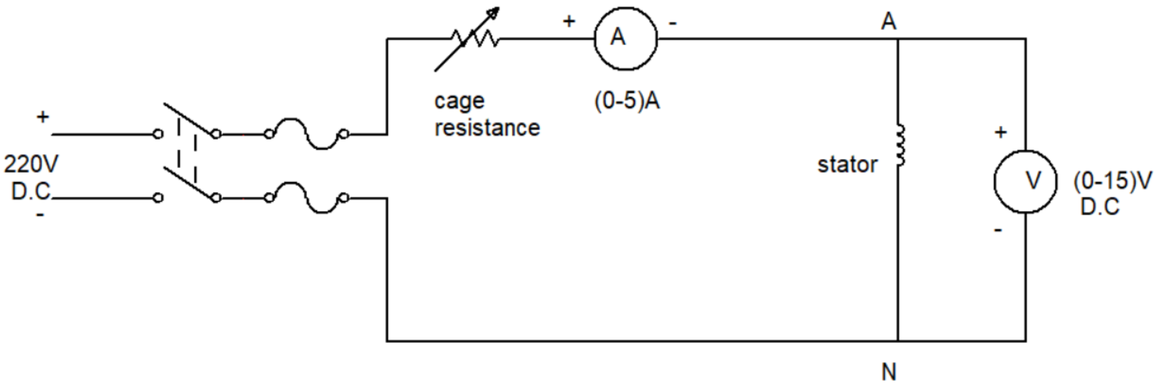
PROCEDURE: (S.C. TEST):

i. Connect the circuit as shown for the S.C. test
ii. Keep the output voltage of the potential divider so that the supply at the rotor d.c. field is at zero
iii. With the field regulator of the motor (M) at its minimum position start the motor as before and adjust the speed of the alternator at the rated value

iv. Very carefully adjust the rotor field current gradually in steps of 4-5 numbers and circulate full load current in the static winding. Slight overloading is allowable. Note the sets of reading in all the instruments

v. Gradually decrease the excitation in the rotor field and switch off the d.c. supplies.

Measurement of R_a: Refer the connection diagram shown below:

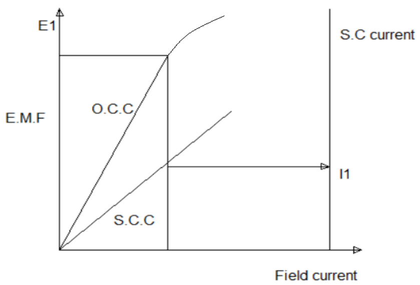


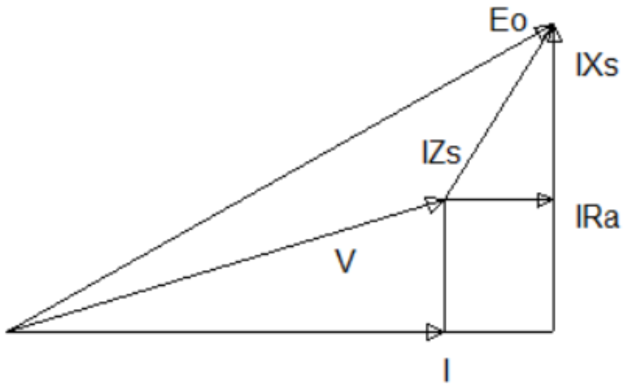
i. With the case resistance (or lamp load) off, switch on d.c. supply.

ii. Put on load and note 3-4 sets of reading in "A" and "V" preferably towards higher side of currents in stator phase winding (AN) and within rated value.

iii. Switch off the load and supply

OBSERVATIONS:



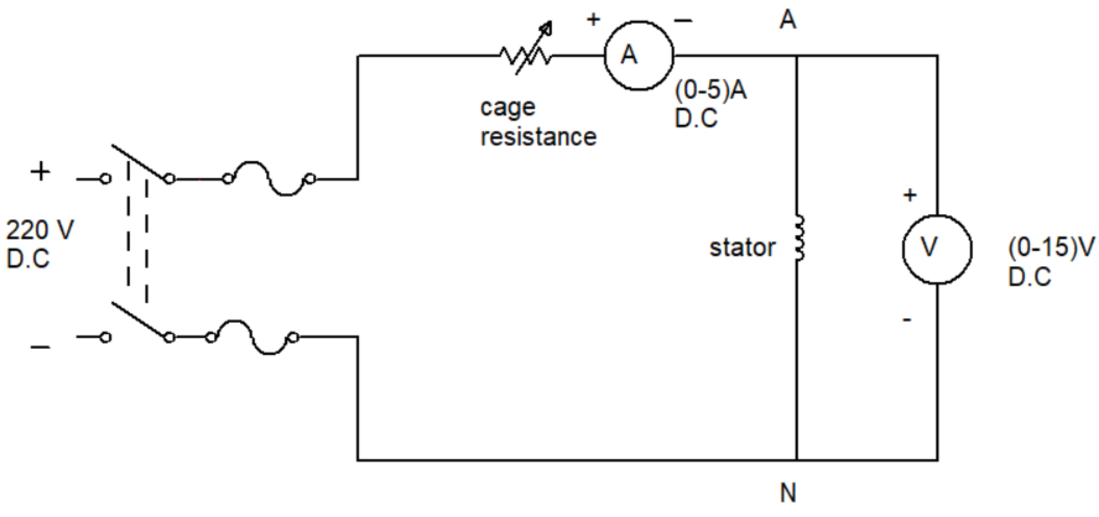


phasor diagram

Let E_1 be the O.C. voltage corresponding to a field current, I_f. When the stator winding is shorted the terminal voltage is zero, meaning that E_1 is being utilized to circulate S.C. current I_1 against the synchronous impedance, Z_s.

Z_s=(E_1(open circuit voltage))/(I_1 (short circuit current))

The effective or the a.c. resistance, R_a of the stator winding/ phase can be determined, as shown below.



The a.c. resistance may be taken as 1.6 times the d.c. value measured. Having known R_a,

$X_s = \sqrt{(Z_s^2 - R_a^2)}$, ohms

Having known R_a, X_s, a phasor diagram can be drawn for any load and power factor as shown, where,

So that the regulator of the alternator can be determined.

i. **O.C. TEST**

SL No	Field current, I_f (amps)	O.C voltage E_0 (volts)	Rated N R.P.M.

ii. **S.C. Test**

SL No	Field current, I_f (amps)	O.C voltage E_0 (volts)	Rated N R.P.M.

iii. Measurement of R_a

SL No	V (volts)	I (amps)	R_a (ohms)	Mean R_a (ohms)	R_a (a.c.) (ohms)

REPORT:

1. Determine the regulation of the alternator at ¼th, ½th, 3/4th and the full load at .8 (lagging) and unity power factor of the load from the experimental data. Plot the necessary for regulation vs load at the power factor given.
2. Derive the condition for maximum regulation of an alternator. Determine the value for this alternator.

N.B. For O.C. first regulate the regulator to make speed 1500. Then take the readings of If & V. Keep the variable point at maximum resistance. Increase current by rheostat slowly & take readings.

Next for S.C. adjust speed to 1500, take readings of If by adjusting rheostat o 18.9 A current in the S.C. ammeter.

Signature of the teacher **Date**