ELECTRICAL TECHNOLOGY

LAB MANUAL

For II-B.Tech (ECE)

Department of EEE

Aurora’s Technological and Research Institute

Parvathapur, Uppal, Hyderabad-500 039

LABORATORY PRACTICE

I HEAR, I FORGET

I SEE, I REMEMBER

I DO, I UNDERSTAND

PRACTCAL APPROACH IS PROBABLY THE BEST APPROACH TO GAIN A CLEAR INSIGHT

CODE OF CONDUCT FOR THE LABORATORIES

- All students must observe the Dress Code while in the laboratory.
- Sandals or open-toed shoes are NOT allowed.
- Foods, drinks and smoking are NOT allowed.
- All bags must be left at the indicated place.
- The lab timetable must be strictly followed.
- Be PUNCTUAL for your laboratory session.
- Experiment must be completed within the given time.
- Noise must be kept to a minimum.
- Workspace must be kept clean and tidy at all time.
- Handle all apparatus with care.
- All students are liable for any damage to equipment due to their own negligence.
- All equipment, apparatus, tools and components must be RETURNED to their original place after use.
- Students are strictly PROHIBITED from taking out any items from the laboratory.
- Students are NOT allowed to work alone in the laboratory without the Lab Supervisor
- Report immediately to the Lab Supervisor if any injury occurred.
- Report immediately to the Lab Supervisor any damages to equipment.

Before leaving the lab

- Place the stools under the lab bench.
- Turn off the power to all instruments.
- Turn off the main power switch to the lab bench.
- **Please check the laboratory notice board regularly for updates**

GENERAL LABORATORY INSTRUCTIONS

- You should be punctual for your laboratory session and should not leave the lab without the permission of the teacher.
- Each student is expected to have his/her own lab book where they will take notes on the experiments as they are completed.
- The lab books will be checked at the end of each lab session. Lab notes are a primary source from which you will write your lab reports.
- You and your batch mates will work closely on the experiments together. One partner doing all the work will not be tolerated. All the Batch mates should be able to explain the purpose of the experiment and the underlying concepts.
- Please report immediately to the member of staff or lab assistant present in the laboratory; if any equipment is faulty.

Organization of the Laboratory

- It is important that the experiments are done according to the timetable and completed within the scheduled time.
- You should complete the prelab work in advance and utilize the laboratory time for verification only.
- The aim of these exercises is to develop your ability to understand, analyze and test them in the laboratory.
- A member of staff and a Lab assistant will be available during scheduled laboratory sessions to provide assistance.
- Always attempt experiments; first without seeking help.
- When you get into difficulty; ask for assistance.

Assessment

- The laboratory work of a student will be evaluated continuously during the semester for 25 marks. Of the 25 marks, 15 marks will be awarded for day-to-day work.
- For each experiment marks are awarded under three heads:
  _ Prelab preparation – 5 marks
  _ Practical work – 5marks, and
  _ Record of the Experiment – 5marks
- Internal lab test(s) conducted during the semester carries 10 marks.
- End semester lab examination, conducted as per the JNTU regulations, carries 50 marks.
- At the end of each laboratory session you must obtain the signature of the teacher along with the marks for the session out of 10 on the lab notebook.

Lab Reports

- Note that, although students are encouraged to collaborate during lab, each must individually prepare a report and submit.
- They must be organized, neat and legible.
- Your report should be complete, thorough, understandable and literate.
- You should include a well-drawn and labeled engineering schematic for each circuit
- Investigated.
- Your reports should follow the prescribed format, to give your report structure and to make sure that you address all of the important points.
- Graphics requiring- drawn straight lines should be done with a straight edge. Well drawn freehand sketches are permissible for schematics.
- Space must be provided in the flow of your discussion for any tables or figures. Do not collect figures and drawings in a single appendix at the end of the report.
- Reports should be submitted within one week after completing a scheduled lab session.

Presentation

- Experimental facts should always be given in the past tense.
- Discussions or remarks about the presentation of data should mainly be in the present tense.
- Discussion of results can be in both the present and past tenses, shifting back and forth from experimental facts to the presentation.
- Any specific conclusions or deductions should be expressed in the past tense.

Report Format

Lab write ups should consist of the following sections:

- **Aim**: A concise statement describing the experiment and the results. This is usually not more than 3 sentences. Since the abstract is a summary of what you have done, it's a good idea to write this last.
- **Apparatus**: Describe what equipment and components you used to conduct the experiment.
- **Theory**: Several paragraphs that explain the motivation of the experiment. Usually in this statement you state what you intent to accomplish as well as the expected results of the experiment.
- **Procedure**: Describe how you conducted the experiment
- **Results and Analysis**: This is the main body of the report. Graphs, tables, schematics, diagrams should all be included and explained. Results of any calculations should be explained and shown. State the results of the experiment. Include any problems encountered.
- **Conclusion**: Explain how the experiment went, and whether you were able to achieve the expected results stated in the introduction.

EEE Department

SAFETY – 1

1. Power must be switched-OFF while making any connections.
2. Do not come in contact with live supply.
3. Power should always be in switch-OFF condition, EXCEPT while you are taking readings.
4. The Circuit diagram should be approved by the faculty before making connections.
5. Circuit connections should be checked & approved by the faculty before switching on the power.
6. Keep your Experimental Set-up neat and tidy.
7. Check the polarities of meters and supplies while making connections.
8. Always connect the voltmeter after making all other connections.
9. Check the Fuse and it's ratify.
10. Use right color and gauge of the fuse.
11. All terminations should be firm and no exposed wire.
12. Do not use joints for connection wire.
13. While making 3-phase motor ON, check its current rating from motor name plate details and adjust its rated current setting on MPCB(Motor Protection Circuit Breaker) by taking approval of the faculty.
14. Before switch-ON the AC or DC motor, verify that the Belt load is unloaded.
15. Before switch-ON the DC Motor-Generator set ON, verify that the DC motor field resistance should be kept in minimum position. Where as the DC generator / AC generator field resistance should be kept in Maximum position.
16. Avoid loose connections. Loose connections leads to heavy sparking & damage for the equipments as well as danger for the human life.
17. Before starting the AC motor/Transformer see that their variacs or Dimmerstats always kept in zero position.

18. For making perfect DC experiment connections & avoiding confusions follow color coding connections strictly. Red colour wires should be used for positive connections while black color wires to be used for Negative connections.
19 After making DPST switch/ICTPN switch-OFF see that the switch in switched-OFF Perfectly or not. Open the switch door & see the inside switch contacts are in open. If in-contact inform to faculty for corrective action.
20 For safety protection always give connections through MCB (Miniature circuit breaker) while performing the experiments.

SAFETY – II

1. The voltage employed in electrical lab is sufficiently high to endanger human life.
2. Compulsorily wear shoes.
3. Don't use metal jewelers on hands.
4. Do not wear loose dress
5. Don't switch on main power unless the faculty gives the permission.

TREATMENT AGAINST SHOCK

(Artificial Respiration)

1. Place him/her on back. Clear his mouth and throat. Turn his/her head to side and remove any foreign bodies with fingers.
2. Tilt his/her head back by holding lower jaw – this gives a clear air passage way to his/her lungs and keep tongue out of throat.
3. You take deep breath of fresh air. Place mouth over his/her nose. Hold mouth closed. Blow into nose. Adults-blow fully, children-puff gently. Watch chest rise. Remove mouth – let chest fall. Continue until patient resumes breathing.

Note: If chest does not rise when you blow check for obstruction in his/her throat.

4. Listen to the air being exhaled. When flow of air stops blow it again.

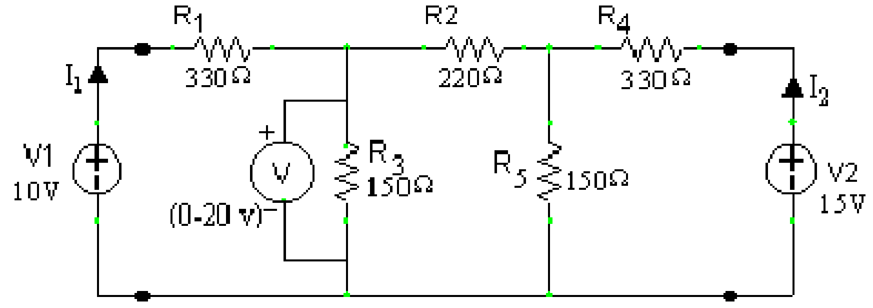
Name of the student: ______________________________

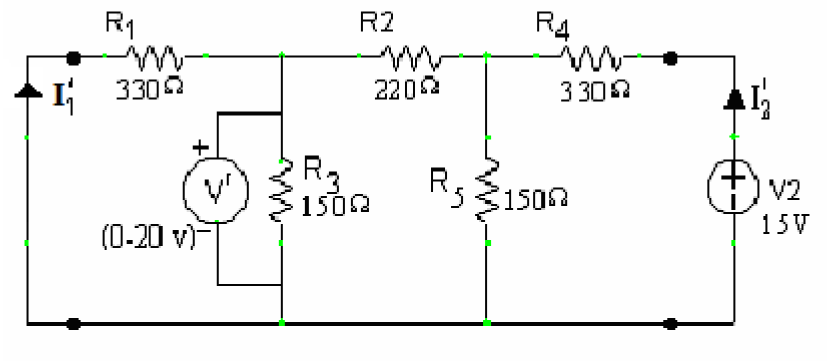
Roll Number: ______________________

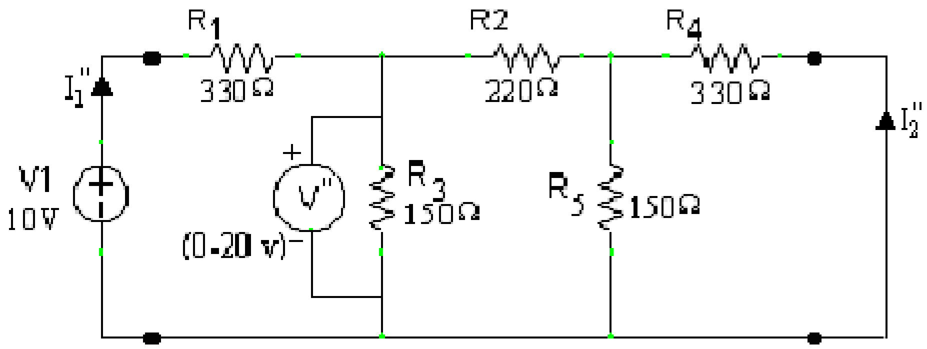
INDEX

Sl. No	Name of the Experiment	Page No.	Date of conduction	Grade/ Marks	Incharge sign.
1	Super Position theorem & Reciprocity Theorems				
2	Maximum Power Transfer theorem.				
3	Thevenin's and Norton's Theorems				
4	SERIES & PARALLEL Resonance				
5	Z & Y Parameters				
6	ABCD & H PARAMETERS				
7	KVL AND KCL				
8	Magnetization characteristics of DC shunt Generator				
9	Swinburne's test on DC shunt Machine				
10	Brake test on a shunt motor				
11	O.C. & S.C. Tests on 1-Phase Transformer				
12	Load test on 1-Phase Transformer				

CIRCUIT DIAGRAM:







Theoretical calculations:

Observations:

S.No	V_1 (volt)	V_2 (volt)	V (v)

S.No	V_1 (volt)	V' (v)

S.No	V_2 (volt)	V'' (v)

1. SUPER POSITION THEOREM AND RECIPROCITY THEOREMS

SUPERPOSITION THEOREM:

AIM: To verify the super position theorem

APPARATUS:

S.No	Equipment	Range	Type	Qty
1	Bread board			
2	Volt meter	(0-30) V	MC	1No
3	Regulated Power Supply	0-30V	Dual	1No
4	Resistors	150 Ω	--	2
		220Ω		1
		330Ω		2

STATEMENT:

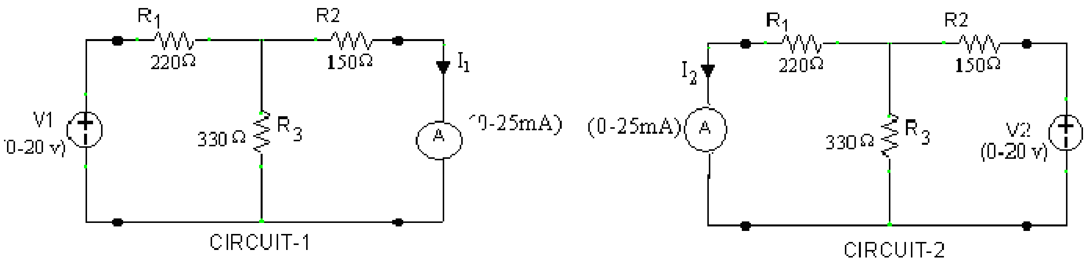
The Super position theorem states that in any linear network containing two or more sources, the response in any element is equal to the sum of the responses caused by individual sources acting alone while the other sources are made inoperative.

PROCEDURE:

1) Connect the circuit as shown in circuit diagram. Switch ON the supply and Note down the reading of the voltmeter as V.
2) Short-circuit the voltage source V_1 as in circuit (2) and Note down the reading of voltmeter as V^{I}.
3) Now short-circuit the voltage source V_2, keeping V_1 in the circuit, as in circuit diagram(3) and Note the reading of voltmeter as V^{II}.
4) If $V = V^{I} + V^{II}$, super position theorem is verified.

Result :

Circuit diagrams:



Theoretical calculations;

Observations:

V_1/I_1 (kΩ)	V_2/I_2 (kΩ)

RECIPROCITY THEOREM:

Aim: To verify the Reciprocity theorem.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	Bread board			
2	Ammeter	(0-25)mA	MC	1No
3	Regulated Power Supply	0-30V	Dual	1No
4	Resistors	150 Ω	--	1
		220Ω	---	1
		330Ω	---	1

Statement: In any bilateral, linear network, if we apply some input to a circuit the ratio of response (output) in any element to the input is constant even when the position of the input and output are interchanged. Another way of stating the above is that the receiving and sending points are interchangeable.

Procedure:

1. Connect the circuit as shown in CIRCUIT-1 and take the reading of Ammeter as I_1.
2. Now change the voltage source to the right hand side as shown in CIRCUIT-2 and measure the current with the help of Ammeter as I_2.
3. If source to response ratio is same i.e. $V_1/I_1=V_2/I_2$, then the Theorem is verified.

Result:

Reasoning Questions:

1) Where we can apply superposition theorem?
2) What is the importance of reciprocity theorem?
3) What is bilateral property of the element?
4) What is the node in the circuit? Define branch in the circuit?
5) State the superposition theorem and reciprocity theorem.

Circuit Diagram:

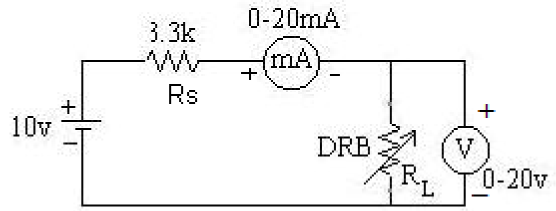


Fig. 1

Theoretical Calculations:

2. MAXIMUM POWER TRANSFER THEOREM

AIM: To verify the Maximum Power Transfer theorem on DC and AC.

APPARATUS:

1. Resistor - 3.3KΩ.
2. Resistance Box
3. DC milli Ammeter - 0-20mA
4. DC Voltmeter - 0-20v
5. Regulated Power Supply.
6. Connecting wires.

THEORY:

For DC Circuit:- The maximum power is said to be delivered from the source to the load when the load resistance is equal to the source resistance.

For the given circuit in fig. 1 maximum power delivered to the load is given by

$$P_{max} = \frac{V_s^2}{4R_L}$$

For AC Circuit:-The maximum power is said to be delivered to the load when the source impedance is complex conjugate of load impedance.

PROCEDURE:

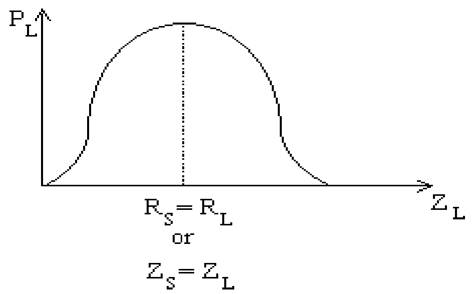
1. Connect the circuit as shown in diagram.
2. Apply 10V DC from the RPS.
3. Take the readings of the milli Ammeter and voltmeter while varying R_L in suitable steps.
4. Tabulate the readings and plot the graph.
5. Verify the maximum power transfer theorem

Observations:

On DC Circuit:

S.No	R_L (Ω)	I (A)	V (V)	P_L (W)

MODEL GRAPH:

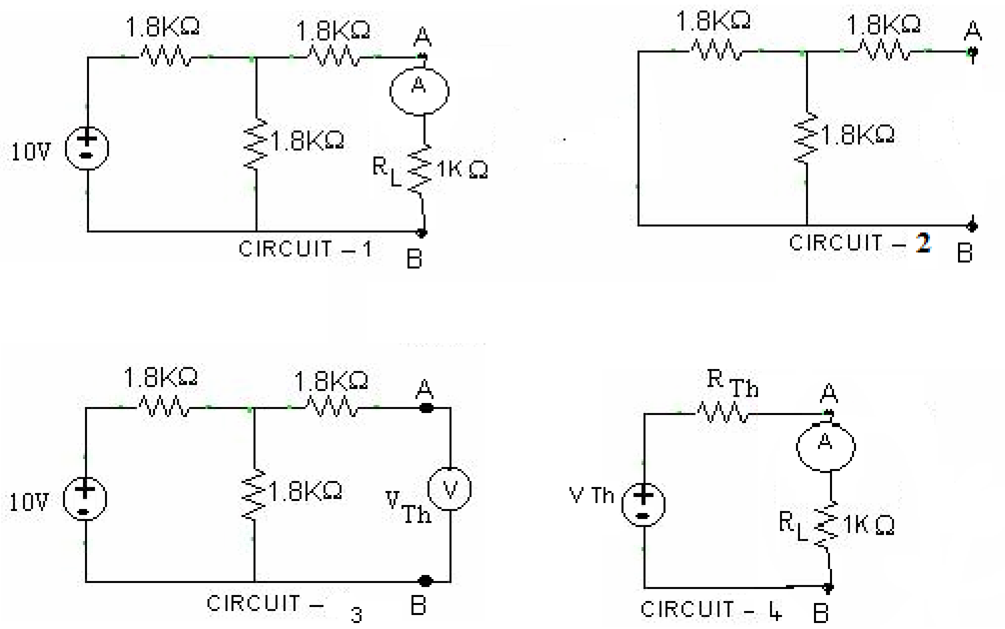


RESULT:

Reasoning Questions:

1 State the maximum power transfer theorem.
2 What are the applications of maximum power transfer theorem?
3 What is the difference in the application of maximum power transfer theorem to AC and DC?
4 Is it possible to find maximum power in any circuit without drawing its equivalent thevenin's circuit?

Circuit diagram:



Theoretical Calculations:

3. THEVENIN'S THEOREM

Aim: To verify the Thevenin's theorem.

Apparatus:

1.	Bread Board.		
2.	Resistors	1.8KΩ	3 No.s
		KΩ	1 No.
3.	Voltmeter	(0-20) V	1 No.
4.	Ammeter	(0-20mA)	1 No.
5.	Multi meter	No.	
6.	Connecting wires.		

THEORY :

Statement: Any linear bilateral network containing one or more voltage sources can be replaced by an equivalent circuit consisting of a single voltage source whose value is equal to the open circuit voltage across the output terminals, in series with Thevenin's equivalent resistance. The Thevenin's equivalent resistance is equal to the effective resistance measured between the output terminals, with the load resistance removed and with all the energy sources are replaced by their internal resistances.

PROCEDURE :

1. Connect the circuit as per CIRCUIT-1. Note down the current through the load resistance.
2. Calculate the value of open circuit voltage, Thevenin's equivalent resistance and the current through the load resistance using Thevenin's theorem.
3. Find out R_{Th} by shorting the voltage source and measuring the equivalent resistance across open circuited R_L (1KΩ) terminals, as in circuit diagram(2), using a multimeter. Compare this value with the calculated value.
4. Remove the load resistor R_L and connect the circuit as per CIRCUIT-3 and Note down the reading of voltmeter as V_{Th}.

Theoretical Calculations:

Theoretical:

Open circuit voltage V_{Th} =

Thevenin's Equivalent Resistance R_{Th} =

Current through the load resistor I_L =

OBSERVATIONS:

Measured

Open circuit voltage V_{Th} =

Thevenin's Equivalent Resistance R_{Th} =

Current through the load resistor I_L =

5. Connect the Thevenin's equivalent circuit as shown in CIRCUIT-4 and Note down the reading of ammeter.

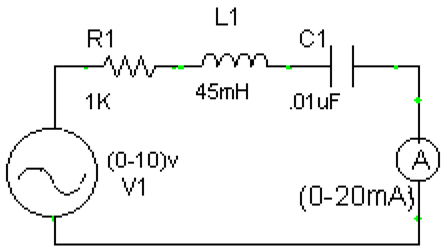
6. If current through the load resistance using Thevenin's theorem is equal to the measured value of the current from circuit-1, Thevenin's Theorems is verified.

RESULT:

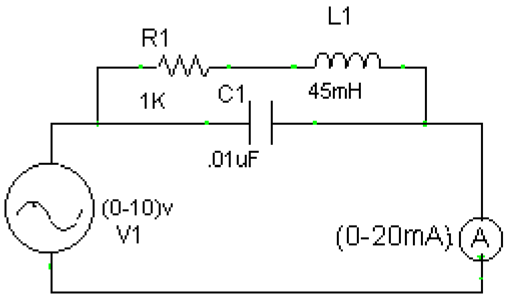
Reasoning questions:

1. Define thevenin's theorem.
2. What are the conditions to apply the thevenin's theorem?
3. What is the importance of Thevenin's theorem?

CIRCUIT DIAGRAM :

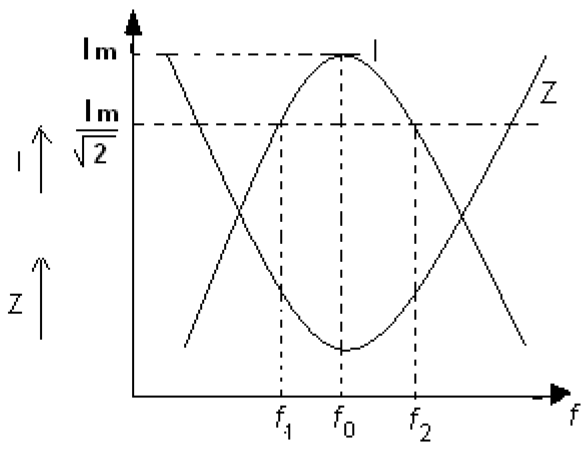


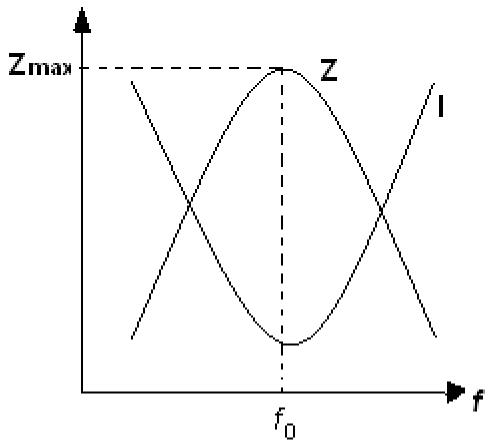
CIRCUIT –1



CIRCUIT-2

EXPECTED GRAPH :





4. SERIES AND PARALLEL RESONANCE

AIM :
To determine resonant frequency, band width and Q-factor for series and parallel RLC circuits

APPARATUS :

	NAME	RANGE	QUANTITY
1.	Resistor	1KΩ	1 No.
2.	Inductor	45mH	1 No
3.	Capacitor	0.01μF	1 No
4.	Milli Ammeter	0-20mA (AC)	1 No
5.	Function generator		

THEORY :

An AC circuit is said to be in Resonance when the applied voltage and current are in phase. Resonance circuits are formed by the combination of reactive elements connected in either series or parallel.

Resonance frequency in series circuit is given by $f_r = 1/(2\pi\sqrt{LC})$ Hz

The impedance of the RLC circuit is

$$Z = R + j(\omega_L - 1/\omega_C) = R + jX$$

The circuit is in resonance when X = 0 ie., when $\omega_L = 1/\omega_C$

In series RLC circuit the current lags behind or leads the applied voltage depending upon the value of X_L and Xc. When X_L is greater than Xc the circuit is inductive and when X_c is greater than X_L, the circuit is capacitive.

Quality factor (Q-factor) or (Selectivity) :

Quality factor can be defined as ,

= 2 π (maximum energy stored)/ (energy dissipated per cycle).

$$= (f_2 - f_1) / f_r$$

Band width: Band width of a resonance circuit is defined as the band of frequencies on either sides of resonance frequency. This frequency range can be obtained by dropping a vertical in the graph at its half power value, i.e., $1/\sqrt{2}$ times of maximum value.

$$\text{Band width} = f_2 - f_1$$

TABULAR COLOUMN :

Series

S. No	I/P V	Frequency, Hz	I_L, Amp	Z=V/I_L Ω

Parallel

S. No	V i/p	Frequency, Hz	I_L, Amp	Z=V/I_L Ω

CALCULATIONS:

For Series Resonance :

$$f_0 = \frac{1}{(2\pi\sqrt{LC})}$$

$$f_1 = f_0 - (R/4\pi L)$$

$$f_2 = f_0 + (R/4\pi L)$$

$$\text{Band width} = f_2 - f_1$$

Q-factor =

For Parallel Resonance :

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$f_1 = f_0 - (R/4\pi L)$$

$$f_2 = f_0 + (R/4\pi L)$$

$$\text{Band width} = f_2 - f_1$$

Q-factor =

THEORETICAL CALCULATIONS :

Series

$$f_0 = \frac{1}{(2\pi\sqrt{LC})}$$

$$f_1 = f_0 - (R/4\pi L)$$

$$f_2 = f_0 + (R/4\pi L)$$

$$\text{Band width} = f_2 - f_1$$

Q-factor =

Parallel

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$f_1 = f_0 - (R/4\pi L)$$

$$f_2 = f_0 + (R/4\pi L)$$

$$\text{Band width} = f_2 - f_1$$

Q-factor =

PROCEDURE :

1. Connect the circuit as shown in diagram(1).
2. Apply 20V (peak to peak) from the Function Generator.
3. Vary the input frequency in suitable steps (starting from 1K Hz to 10K Hz in step of 500 Hz).
4. Note down the readings of the milli Ammeter for different values of frequency.
5. Calculate the Impedance Z.
6. Plot the graphs for current Vs frequency and Z Vs frequency.
7. Identify the values of f_0 , f_1 and f_2 from the graph, Calculate the Q-factor and Band width.
8. Compare with theoretical values.
9. Connect the circuit as per diagram(2).
10. Repeat steps (2) & (3).
11. Note down the readings of the voltmeter and milliammeter for different frequencies.
12. Calculate the Impedance Z.
13. Plot the graphs for current Vs frequency and Z Vs frequency
14. Also plot the graph of Voltage Vs Frequency.
15. Identify the values of f_0 , f_1 and f_2 from the graph, Calculate the Q-factor and Band width.

RESULT :

CONCLUSION :

CIRCUIT DIAGRAM:

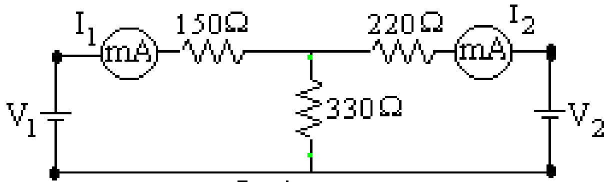


fig-1

OBSERVATIONS & CALCULATIONS :

For Z-parameters

When V_2 is open circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$Z_{11} = V_1 / I_1$ ($I_2 = 0$)

$Z_{21} = V_2 / I_1$ ($I_2 = 0$)

When V_1 is open circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$Z_{12} = V_1 / I_2$ ($I_1 = 0$)

$Z_{21} = V_1 / I_1$ ($I_1 = 0$)

For Y -parameters

When V_2 is short circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$Y_{11} = I_1 / V_1$ ($V_2 = 0$) =

$Y_{21} = I_2 / V_1$ ($V_2 = 0$)

When V_1 is short circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$Y_{12} = I_1 / V_2$ ($V_1 = 0$)

$Y_{22} = I_2 / V_2$ ($V_2 = 0$)

5. Z & Y PARAMETERS

AIM :

To determine the Z, and Y parameters of a Two-port network.

APPARATUS :

	Name	Type / Range	Quantity
1.	Resistors	- 150Ω, 220Ω and 330Ω	each 1 No.s
2.	milli Ammeter	- (0-20mA)	2 No.s
3.	Voltmeter	- (0-20v)	1 No
4.	Regulated power Supply	- 30 V, 2A	1 No.
5.	Connecting wires.		

THEORY :

A network is having two pairs of accessible terminals, it is called a two port network. If voltage and current at the input and output terminals are V_1 , I_1 and V_2 , I_2 respectively, there are six sets of possible combinations generated by the four variables, describing a two - port network. Z - parameters and Y- parameters are two among them.

Using Z- parameters the circuit can be represented by the following equations

$V_1 = Z_{11} I_1 + Z_{12} I_2$

$V_2 = Z_{21} I_1 + Z_{22} I_2$

Using Y- parameters the circuit can be represented by the following equations

$I_1 = Y_{11} V_1 + Y_{12} V_2$

$I_2 = Y_{21} V_1 + Y_{22} V_2$

PROCEDURE :

Z- parameters:-

1. Connect the circuit as shown in diagram – 1.

For Z_{11} and Z_{21} :

1. Make $I_2 = 0$ by open circuiting the V_2 and Apply $V_1 = 10V$.
2. Note down the readings of V_1, V_2 and I_1.
3. Calculate Z_{11} and Z_{21} .

Verify with theoretical values.

For Z_{12} and Z_{22} :

1. Make $I_1 = 0$ by open circuiting the V_1 and Apply $V_2 = 15V$.
2. Note down the readings of V_1, V_2 and I_2.
3. Calculate Z_{12} and Z_{22}.
4. Verify with theoretical values.

Y- parameters :-

1. Connect the circuit as shown in diagram – 1.

For Y_{11} and Y_{21} :

1. Make $V_2 = 0$ by short circuiting it and Apply V_1=10v.
2. Note down the readings of I_1, I_2 and V_1.
3. Calculate Y_{11} and Y_{21} .
4. Verify with theoretical values.

For Y_{12} and Y_{22} :

1. Make $V_1 = 0$ by short circuiting it and Apply V_2 = 15v.
2. Note down the readings of I_1, I_2 and V_2.
3. Calculate Y_{12} and Y_{22}.
4. Verify with theoretical values.

CIRCUIT DIAGRAM :

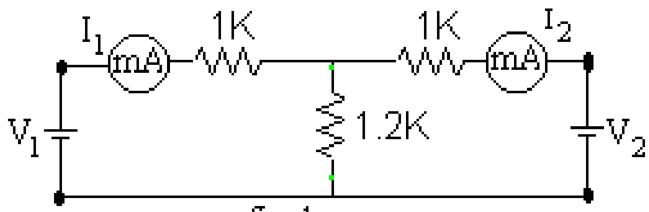


fig-1

OBSERVATIONS & CALCULATIONS :

For T-parameters

When V_2 is short circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$B = V_1 / I_2$ ($V_2 = 0$)

$D = I_1 / I_2$ ($V_2 = 0$)

When V_2 is open circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$A = V_1 / V_2$ ($I_2 = 0$)

$C = I_1 / V_2$ ($I_2 = 0$)

For h -parameters

When V_2 is short circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$h_{11} = V_1 / I_1$ ($V_2 = 0$)

$h_{21} = I_2 / I_{21}$ ($V_2 = 0$)

When V_1 is open circuited,

V_1 (volt)	V_2 (volt)	I_1 (A)	I_2 (A)

$h_{12} = V_1 / V_2$ ($I_1 = 0$)

$h_{22} = I_2 / V_2$ ($I_1 = 0$)

6. TRANSMISSION AND HYBRID PARAMETERS

AIM :

To determine the Transmission and Hybrid parameters of a Two-port network.

APPARATUS :

	Name	Type / Range	Quantity
1.	Resistors -	150Ω, 220Ω and 330Ω	each 1 No.s
2.	milli Ammeter -	(0-20mA)	2 No.s
3.	Voltmeter -	(0-20v)	1 No
4.	Regulated power Supply -	30 V, 2A	1 No.
5.	Connecting wires.		

THEORY :

A network is having two pairs of accessible terminals, it is called a two port network. If voltage and current at the input and output terminals are V_1 , I_1 and V_2 , I_2 respectively, there are six sets of possible combinations generated by the four variables, describing a two - port network. Transmission- parameters and Hybrid-parameters are two among them.

Using T- parameters the circuit can be represented by the following equations

$$V_1 = A V_2 - B I_2$$

$$I_1 = C V_2 - D I_2$$

Where A, B, C, D are the transmission parameters.

Using h- parameters the circuit can be represented by the following equations

$$V_1 = h_{11} I_1 + h_{12} V_2$$

$$I_2 = h_{21} I_1 + h_{22} V_2$$

h_{11}, h_{12}, h_{21} , h_{22} are the hybrid parameters.

PROCEDURE :

T- parameters :-

a. Connect the circuit as shown in diagram – 1.
b. Make $V_2 = 0$ by short-circuiting it and Apply V_1=10V.
c. Note down the readings of V_1, I_2 and I_1.
d. Calculate the values of B and D.
e. Make $I_2 = 0$ by open-circuiting V_2 and Apply V_1=10V
f. Note down the readings of V_1, V_2 and I_1.

g. Calculate the values of A and C

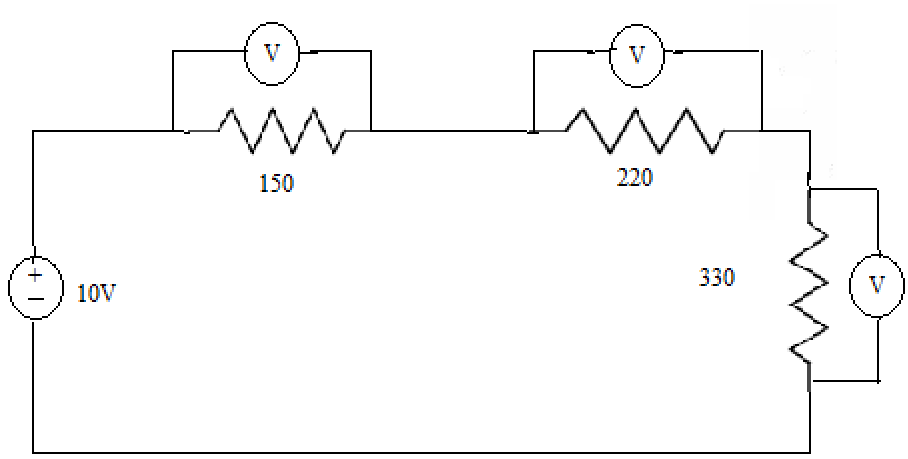
h. Verify with theoretical values.

h – parameters :-

1. Connect the circuit as shown in diagram – 1.
2. Make $V_2 = 0$ by short-circuiting it and Apply V_1=10V.
3. Note down the readings of V_1, I_2 and I_1.
4. Calculate the values of h_{11} and h_{21}.
5. Make I_1=0 by open-circuiting V_1 and Apply V_2=10V
6. Note down the readings of V_1, V_2 and I_1.
7. Calculate the values of h_{12} and h_{22}.
8. Verify with theoretical values.

CIRCUIT DIAGRAM:

CIRCUIT FOR KVL:



THEORITICAL CALCULATIONS:

OBSERVATIONS FOR KVL:

V(v)	V1(v)	V2(v)	V3(v)	V=V1+V2+V3

7. KVL AND KCL

Aim: To verify KVL and KCL.

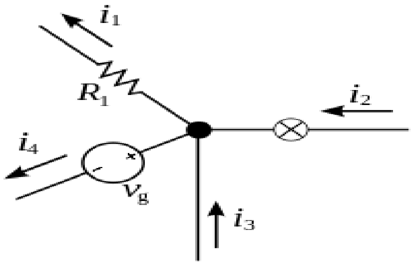
APPARATUS :

	Name		Type / Range	Quantity
1.	Resistors	-	150Ω, 220Ω and 330Ω	each 1 No.s
2.	milli Ammeter	-	(0-20mA)	3 No.s
3.	Voltmeter	-	(0-20v)	3 No.s
4.	Regulated power Supply	-	30 V, 2A	1 No.
5.	Connecting wires.			

THEORY:

Kirchhoff's circuit laws are two equalities that deal with the current and potential difference (commonly known as voltage) in the lumped element model of electrical circuits. They were first described in 1845 by German physicist Gustav Kirchhoff. This generalized the work of Georg Ohm and preceded the work of Maxwell. Widely used in electrical engineering, they are also called Kirchhoff's rules or simply Kirchhoff's laws.

Kirchhoff's current law (KCL)



The current entering any junction is equal to the current leaving that junction. $i_2 + i_3 = i_1 + i_4$

This law is also called Kirchhoff's first law, Kirchhoff's point rule, or Kirchhoff's junction rule (or nodal rule).

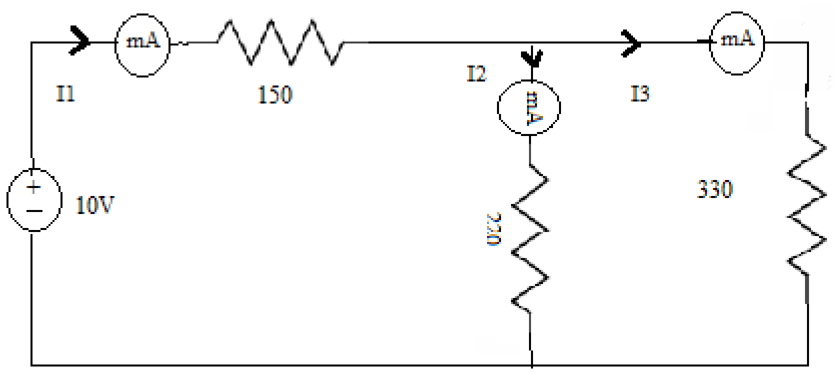
The principle of conservation of electric charge implies that:

At any node (junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node or equivalently
The algebraic sum of currents in a network of conductors meeting at a point is zero.

Recalling that current is a signed (positive or negative) quantity reflecting direction towards or away from a node, this principle can be stated as:

$$\sum_{k=1}^{n} I_k = 0$$

CIRCUIT DIAGRAM FOR KCL:

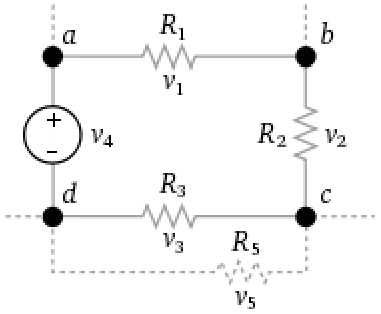


THEORITICAL CALCULATIONS:

OBSERVATIONS FOR KCL:

V(v)	I1(mA)	I2(mA)	I3(mA)	I1=I2+I3

Kirchhoff's voltage law (KVL)



The sum of all the voltages around a loop is equal to zero.
$v_1 + v_2 + v_3 - v_4 = 0$

This law is also called Kirchhoff's second law, Kirchhoff's loop (or mesh) rule, and Kirchhoff's second rule.

The principle of conservation of energy implies that

> The directed sum of the electrical potential differences (voltage) around any closed network is zero, or:
> More simply, the sum of the emfs in any closed loop is equivalent to the sum of the potential drops in that loop, or:
> The algebraic sum of the products of the resistances of the conductors and the currents in them in a closed loop is equal to the total emf available in that loop.

Similarly to KCL, it can be stated as:

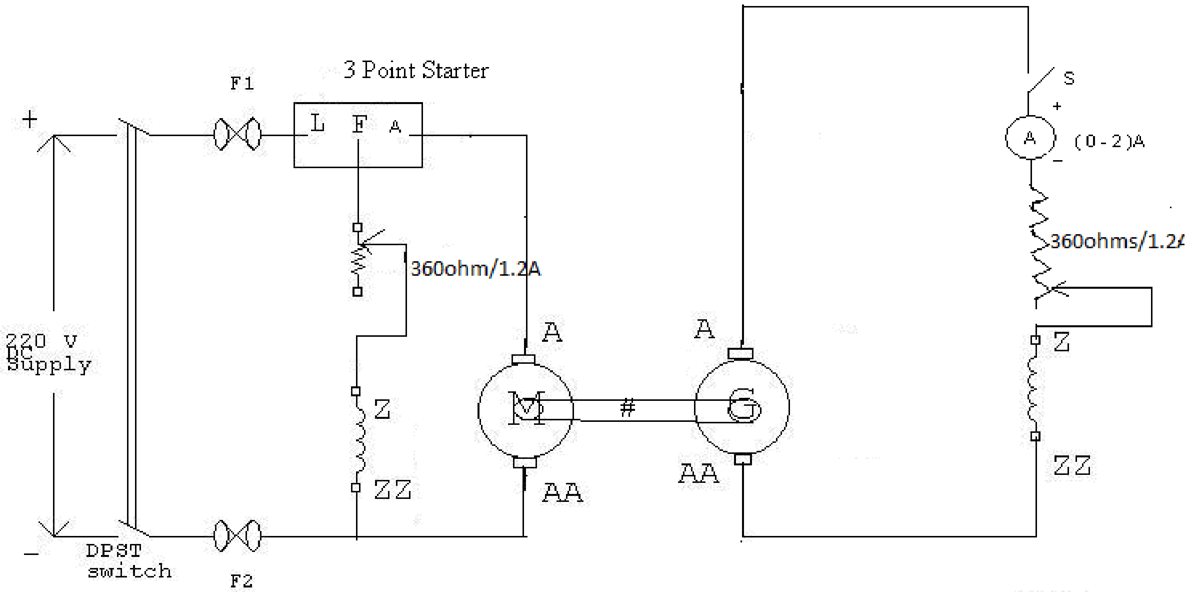
$$\sum_{k=1}^{n} V_k = 0$$

PROCEDURE:

1. Connect the circuit as per the circuit shown for KVL
2. Take the reading of voltmeters v1, v2 and v3.
3. If supply is equal to the sum of these three voltmeters then KVL is verified.
4. Connect the circuit again for KCL as per given diagram.
5. Take the readings of ammeters.
6. If I1=I2+I3, then KCL is verified.
7. check these values with theoretically calculated values.

RESULT:

Circuit Diagram



8. Magnetization characteristics of DC Shunt Generator

Aim: To conduct an experiment on a D.C shunt generator and draw the magnetization characteristics (OCC) and to determine the critical field resistance and critical speed.

Apparatus:

S. No	Apparatus	Type	Range	Qty
1	Voltmeter	M.C	0-300V	1
2	Ammeter	M.C	0-2A	1
3	Rheostats	Wire wound	200Ω/2A 1500Ω/1.2A	1each
4	Tachometer	Digital	-	1

Name plate details:

	Generator
Voltage	
Current	
HP/KW Rating	
Speed	

Theory:

Open circuit characteristics or magnetization curve is the graph between the generated emf and field current of a dc shunt generator. For field current equal to zero there will be residual voltage of 10 to 12V because of the residual magnetism present in the machine .If this is absent, the machine can not build up voltage. As the current through the field increases, the generated emf also increases up to a particular value, and after the point of saturation the emf almost remains constant.

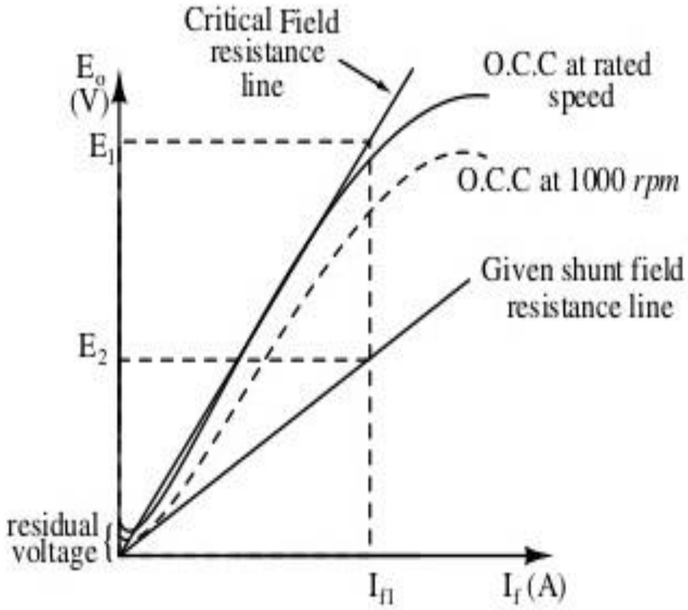
Critical field resistance: It is the minimum value of field resistance above, which the machine can't build up emf.

Critical speed: It is the speed below which the machine cannot build up emf.

Observation:

S.NO	Field current I_f (A)	Generated voltage E_g (V)

Graph:



Critical resistance at rated speed,

$$R_c = \frac{E_1}{I_{f1}} = \text{.........}$$

Critical speed of the Machine,

$$N_c = \left(\frac{E_2}{E_1}\right) N_1 = \text{.........}$$

Procedure:

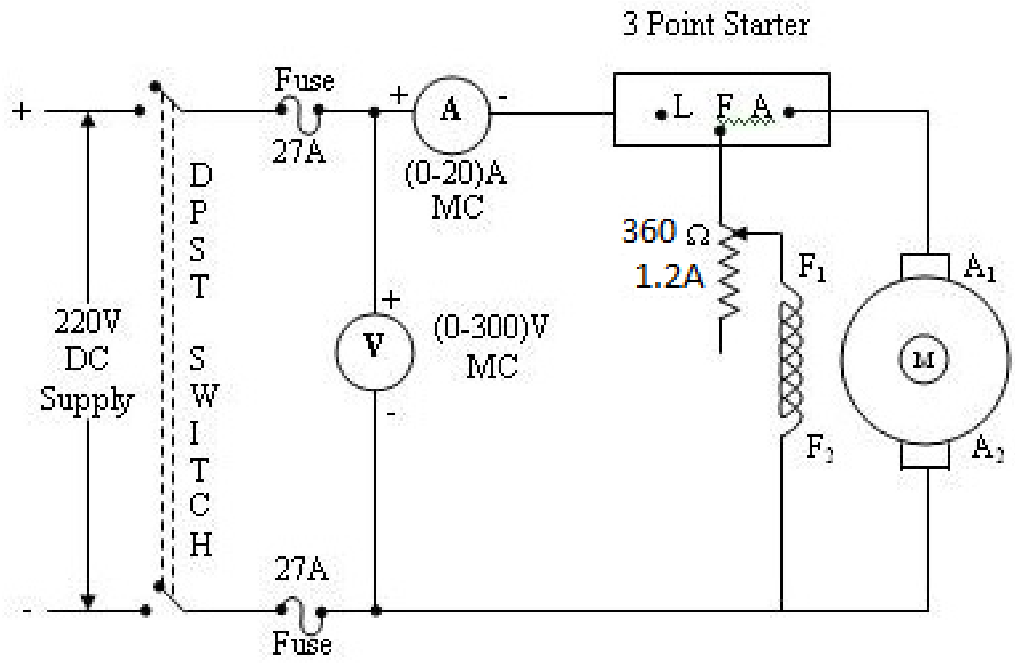
1. Make the connections as per the circuit diagram. Ensure that the external rheostat connected in the motor field circuit is in the minimum position and the external rheostat connected in the generator field circuit is in the maximum position. The switch S in the generator field circuit should be open.
2. Switch ON the circuit. Start the motor using the starter.
3. Adjust the rheostat in the motor field circuit and run the motor at rated speed. The speed should remain constant throughout the experiment.
4. Note down the voltmeter and ammeter readings.
5. Close the switch S.
6. For the different values of excitations (I_f), note down the generated voltage (Eg) from the voltmeter, till the rated values are reached.
7. Switch OFF the supply. Measure the armature resistance.
8. Draw the graph between Eg & I_f. From the graph (OCC), Critical field resistance and critical speed are calculated.

Result:

Reasoning Questions:

1. What is Open Circuit Characteristics?
2. What are the reasons because of which a generator fails to build up the voltage?
3. How the field resistance can go above the Critical field resistance value?
4. While finding out the magnetization characteristics, we should change the field rheostat only in one direction. Why?
5. Why is the magnetization curve not starting from zero?

Circuit diagram



Theoretical calculations;

Efficiency as a motor:

I= Assumed load current

Motor i/p=VI

$Ia=I_L-I_f$

Motor armature losses=$I^2_a .R_a$

Total losses=$I^2_a R_a$+ Wc

Efficiency of motor= VI- $I^2_a R_a$+ Wc / VI x 100

Efficiency as generator:

I=assumed load current

Generator O/P =VI

Generator armature cu. Losses= $I^2_a .R_a$

Total losses= $I^2_a R_a$+ Wc

Efficiency of generator=VI / VI+ $I^2_a R_a$+ Wc

9. SWINBURNE'S TEST ON DC SHUNT MACHINE

Aim: To perform no load test on dc motor and to predetermine the efficiencies of the machine acting as a motor and generator.

Apparatus:

S. No	Apparatus	Type	Range	Qty
1	Voltmeter	MC	0-300v	1
2	Ammeter	MC	0-5A	1
3	Ammeter	MC	0-2A	1
4	Rheostats	Wire wound	200Ω/2A	2

Name plate details:

	Motor
Rated Voltage	220V
Rated Current	21A
Rated Power	3.5KW
Rated Speed	1500rpm

Theory:

It is simple indirect method in which losses are measured separately and the efficiency at any desired load can be predetermined. This test applicable to those machines in which flux is practically constant i.e. shunt and compound wound machines. The no load power input to armature consist iron losses in core, friction loss, windage loss and armature copper loss. It is convenient and economical because power required to test a large machine is small i.e. only no load power. But no account is taken the change in iron losses from no load to full load due to armature reaction flux is distorted which increases the iron losses in some cases by as 50%. Figure 1 shows the circuit diagram for conducting Swinburne's test and Figure 2 shows the circuit diagram for measuring armature resistance of machine.

Observations:

S.No.	Line Current (I_L)	Shunt Field Current (I_f)	Armature Current (Ia)	Line Voltage (V_L)	Speed N

For Measuring R_a

S. No	V	I	R_a=V/I

Experimental Calculations:

No load input=V I_{NL} W

No load armature copper losses =Ia^2 Ra = $(I_{NL} - I_f)^2 R_a$ Watts

Constant losses $W_c = VI_{NL} - (I_{NL} - I_f)^2$ Ra watts

From name plate Rating of motor in watts = P watts

Full load current in Amps = I_{FL} Amps

W_{cu} = Full Load copper losses = $(I_{FL} - I_f)^2$ Ra watts

Total losses $P_L = W_c + W_{cu}$ watts

As Generator efficiency = $ng = \frac{P}{P + P_L}$

As motor efficiency = $\eta_m = \frac{P - P_L}{P}$

Procedure:

1.Make the connections as per circuit diagram.

2.Start the machine as a motor under no-load conditions with help of starter

3.Bring the motor speed to rated speed by varying field rheostat.

4.Take down the no-load readings.

5.Bring the field rheostat to the minimum position and stop the supply.

6.Measure the armature resistance.

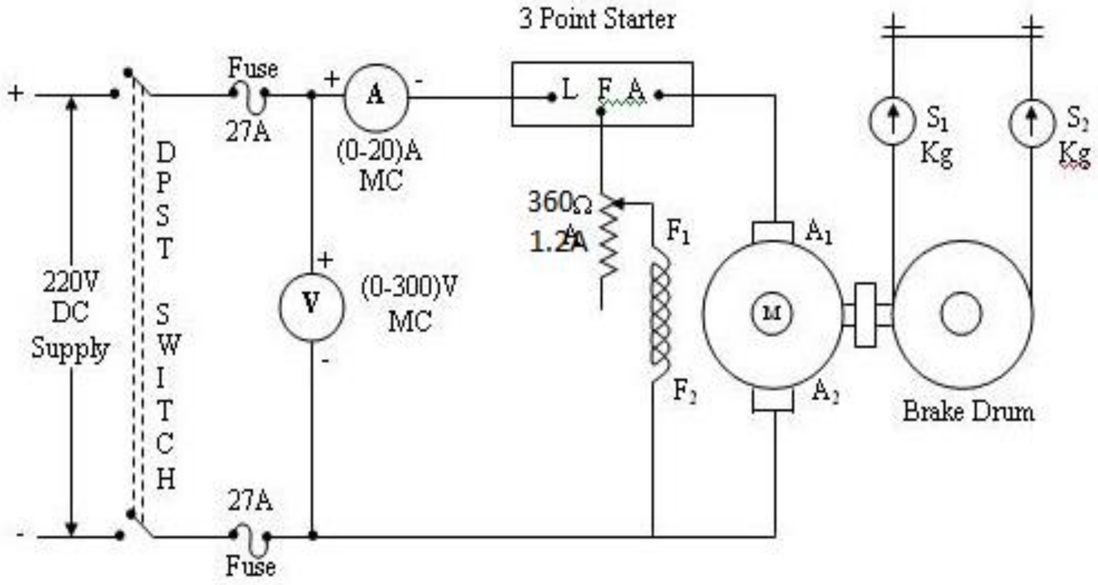
7.Note down the name plate details.

Results:

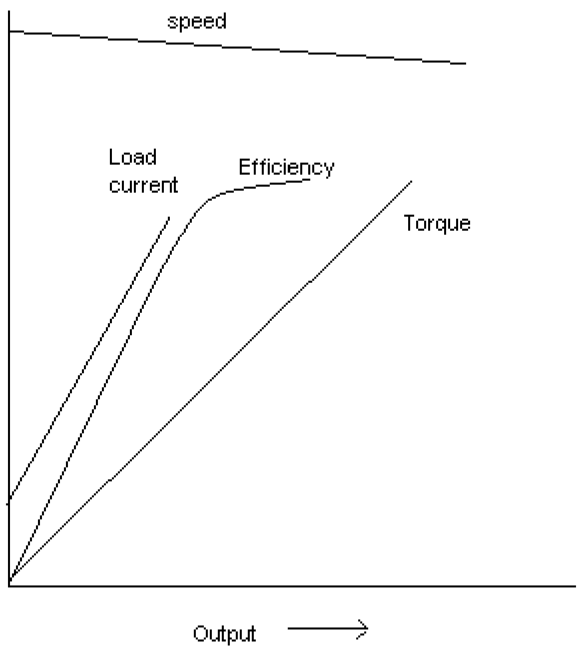
Reasoning Questions:

1. Differences between DC generator and DC motor?
2. Why the total input is taken as losses, in Swinburne's test?
3. Define no – load copper losses?
4. Why efficiency of generator is more than motor even when the machine is same?
5. What is the pessimistic approach in Swinburne's test?
6. Where do we use Swinburne's test?

Circuit diagram:



Expected Graphs:



10. BRAKE TEST ON A DC SHUNT MOTOR

AIM:

To study the performance of a DC shunt motor by conducting Brake test.

NAME PLATE DETAILS:

	Motor
Voltage	220 V
Current	21A
H.P. / K W Ratings	3.5 KW
Speed	1500 rpm

APPARATUS REQUIRED:

S.No.	Name of the equipment	Type	Range	Quantity
1	Voltmeter	MC	0-300V	1
2	Ammeter	MC	(0-20)A	1
3	Rheostats	Wire wound	200Ω/2A 1500Ω / 1.2 A	1 each
4	Tachometer	Digital		1

THEORY:

It is a direct method in which a braking force is applied to a pulley mounted on the motor shaft. A belt is wound round the pulley and its two ends are attached to the frame through two spring balances S_1 and S_2. The tension of the belt can be adjusted with the help of tightening wheel. The tangential force acting on the pulley is equal to the difference between the readings of the two spring balances.

Spring balance readings are S_1 and S_2 in Kg.

Radius of the shaft is R meters

Speed of the motor is N rpm.

Observations:

S no	Speed(N)	V (volt)	I(A)	S1(Kg)	S2 (Kg)	T(Nm)	Output (W)	Input (W)	Efficiency (%)

Sample calculations:

Input voltage across the motor is V volts

Input current is I amps

Torque (T) = $(S_1 - S_2)$ R x 9.81 N-m.

Motor output = $2\pi NT / 60$ watts

Motor input = VI watts

Efficiency = output / input = $2\pi NT / 60 (VI)$

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Ensure minimum resistance in the field circuit and check the brake drum for free rotation.
3. Switch on the supply and slowly push the starter till the end.
4. Adjust the speed of the motor to the rated value by adjusting field resistance.
5. Take the No-load readings of voltmeter, Ammeter and speed.
6. Slowly increase the load on the brake pulley by tightening the wheels in steps. At each step mote down the readings of voltmeter, Ammeter, spring balance readings and speed.
7. Release the load on the pulley and switch OFF the supply.

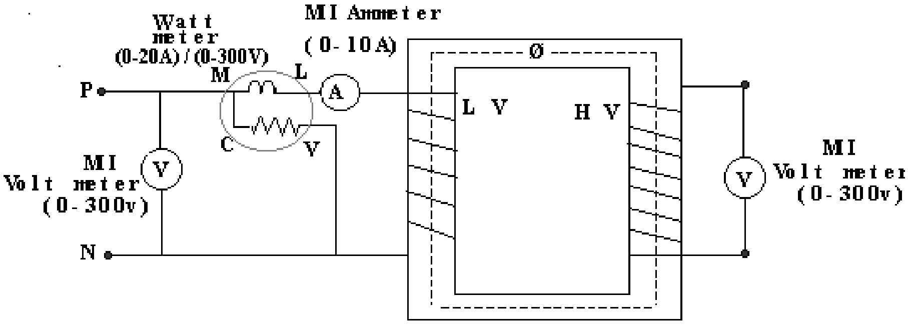
PRECAUTIONS:

1. Avoid hanging wires and loose connections.
2. Make sure that the initial value of Field Resistance is kept at minimum.
3. Ensure that the loading belt is slack when the machine is started.

Result:

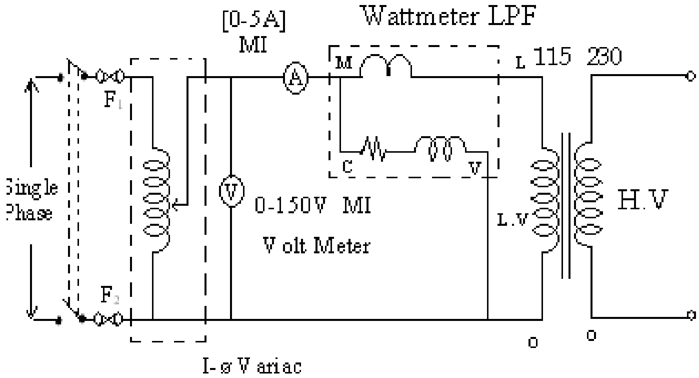
Conclusion:

CIRCUIT DIAGRAM:

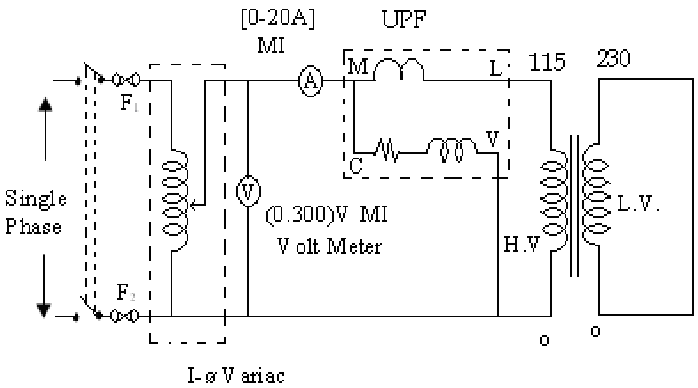


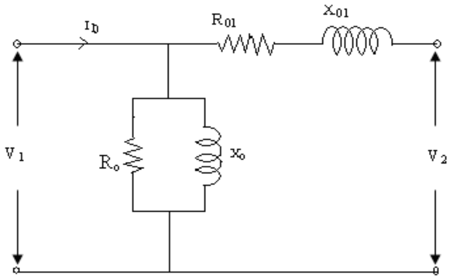
Single Ø Transformer

OC Test :



SC Test :





EQUIVALENT CIRCUIT FOR OC AND SC TEST

11. O.C & S.C TESTS ON 1-ϕ TRANSFORMER

Aim: To conduct OC & SC tests on the given 1-Φ Transformer and to calculate its equivalent circuit parameters, efficiency & regulation.

Apparatus required:

S.NO	DESCRIPTION	RANGE	TYPE	QTY
OC TEST				
1	Voltmeter	0-150V	M.I	1 No
2	Ammeter	0-2.5A	M.I	1 No
3	Wattmeter	2.5A/150V	Dynamo meter (LPF)	1 No
4	Auto T/F	230V/0-270V, 8A	1-ϕ wire wound	1 No
SC TEST				
1	Voltmeter	0-50V	M.I	1 No
2	Ammeter	0-5A	M.I	1 No
3	Wattmeter	5A/50V	Dynamo meter(UPF)	1 No
4	Auto T/F	230V/0-270V, 8A	1-ϕ wire wound	1 No

Name plate details:

1-ϕ TRANSFORMER	
Capacity	
primary voltage	
primary current	
secondary voltage	
Secondary current	
Frequency	

Observations:

O.C Test:

V_0 Volt	I_0 ampere	W_0 watt

S.C Test:

V_{SC} Volt	I_{SC} ampere	W_{SC} watt

Calculations:

Load	Load current (A)	Cu losses(W)	Total losses (W)	I/P power (W)	O/P power (W)	% η
Full						
¾						
½						
¼						

(Cos Φ) P.F.	% Regulation	
	Lag	Lead
0 0.2 0.4 0.6 0.8 1.0		

Theory:

Transformer is a static device, which transfers electrical power from one circuit to another circuit either by step up or step down the voltage with corresponding decrease or increase in the current, without changing the frequency.

OC Test:

The main aim of this test is to determine the Iron losses & No-load current of the T/F. Which are helpful in finding R_o & X_o. In this test generally supply will be given to primary and secondary kept open. Since secondary is opened a small current (magnetizing current) will flow and it will be 5 to 10% of full load current. The wattmeter connected in primary will give directly the Iron losses (core losses). Figure 1 shows circuit diagram for open circuit test.

SC Test:

The main aim of this test is to determine the full load copper losses which is helpful in finding the R_{01}, X_{01}, Z_{01}, efficiency and regulation of the T/F. Generally low voltage side will be short circuited and supply will be given to high voltage side & it will be of 5-10% of the rated voltage. The wattmeter connected in primary will give directly the full load copper losses of the T/F. Figure 2 shows circuit diagram for short circuit test.

Procedure:

OC Test:

1) Give connections as per circuit diagram. Ensure that the autotransformer is in minimum position.
2) Switch-ON the supply and apply rated voltage to the primary of the winding by using autotransformer.
3) Note the readings of Ammeter, Voltmeter & Wattmeter.
4) Bring the autotransformer back to zero position and switch OFF the supply.

SC Test:

1) Give connections as per the circuit diagram.
2) Switch-ON the supply and vary the Dimmerstat (autotransformer) till rated full load current flows through transformer.
3) Note the readings of Ammeter, Voltmeter & Wattmeter
4) Bring the autotransformer back to zero position and switch OFF the supply.

Formulae:

For Efficiency Let load current = I_L, Cu. loss $W_{cu} = (I_L/I_{SC})^2 \times W_{SC}$

Iron loss = W_o, Total loss $W_T = W_{CU}+W_o$, Input power pin = VI Cosø – W_T

$$\eta = \frac{Pout}{Pin} \times 100.$$

For Regulation $\% R = \frac{I_1R_{01}Cos\phi + I_1X_{01}Sin\phi}{V_1} \times 100$

$I_1 = Isc$, $W_{SC} = I_{SC}^2R_{o1}$; ; $R_{01} = W_{SC}/I_{SC}^2$

$Z_{01} = V_{SC}/I_{SC}$, s

$X_{01}=\sqrt{Z_{01}^2 - R_{01}^2}$

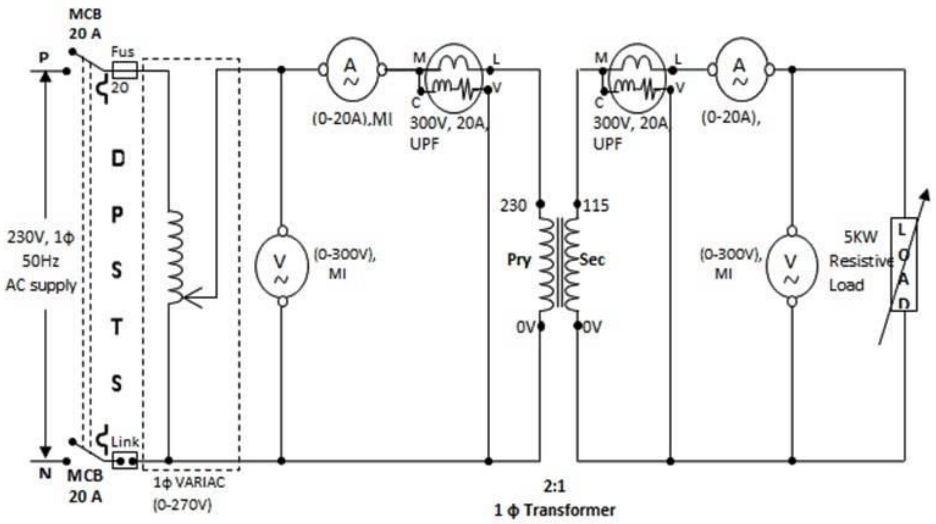
$V_1 = V_0$

Result:

Reasoning Questions:

1. Why is the OC test result taken as the iron loss?
2. Why the SC test is result taken as the copper loss?
3. In OC test, why is the HV side left open?
4. In SC test, why do we short the LV side?
5. Where do we use this test to calculate the efficiency?

CIRCUIT DIAGRAM



12. LOAD TEST ON 1-ϕ TRANSFORMER

Aim: To conduct load test on the given 1-Φ Transformer and to calculate its efficiency & regulation.

Apparatus required:

S.NO	DESCRIPTION	RANGE	TYPE	QTY
1	Voltmeter	0-150V	M.I	1 No
2	Ammeter	0-5A	M.I	1 No
3	Wattmeter	10A/150V	Dynamo meter (UPF)	1 No
4	Auto T/F	230V/0-270V, 8A	1-ϕ wire wound	1 No
4	Auto T/F	230V/0-270V, 8A	1-ϕ wire wound	1 No

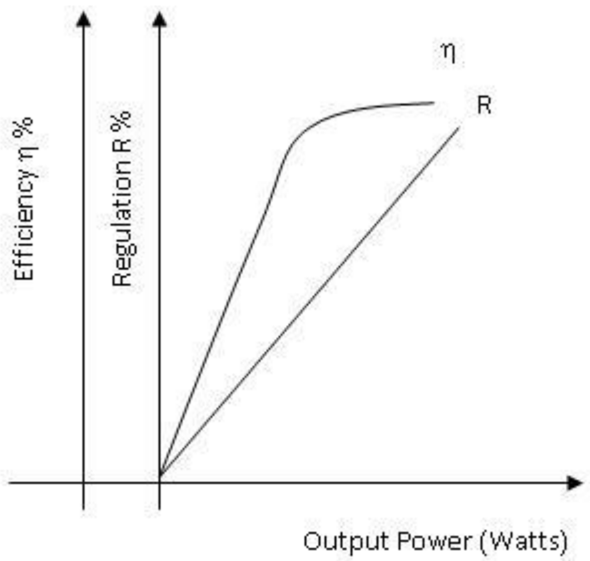
Name plate details:

1-ϕ TRANSFORMER	
Capacity	
primary voltage	
primary current	
secondary voltage	
Secondary current	
Frequency	

Observation table:-

S.No.	Input power W_1	Output voltage V_2	Output current I_2	$\eta=\frac{V_2 I_2}{W_1}*100$	$\%VR=\frac{E_2-V_2}{E_2}*100$

MODEL GRAPH



PROCEDURE:

1) Give connections as per circuit diagram. Ensure that the autotransformer is in minimum position.
2) Switch-ON the supply and apply rated voltage to the primary of the winding by using autotransformer.
3) Note the readings of Ammeter, Voltmeter & Wattmeter by changing the load.
4) Bring the autotransformer back to zero position and switch OFF the supply

RESULT: