Geethanjali College of Engineering & Technology

ELECTRICAL TECHNOLOGY LAB MANUAL

II-B.Tech II-SEMESTER(ECE),2015-2016

Prepared
By
B.RAMESH BABU,
M.Pradeep
manjul khare
pooja raani
Assistant professor(s),
Eee department.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Geethanjali College of Engineering & Technology

Cheeryal (V), Keesara (M), R.R.Dist-501301

ACKNOWLEDGEMENT

It is one of life's simple pleasures to say thank you for all the help that one has extended their support. I wish to acknowledge and appreciate **Asst Prof T.POOJA RANI** for their sincere efforts made towards developing the Power Electronics and Simulation lab manual. I wish to thank students for their suggestions which are considered while preparing the lab manuals.

I am extremely indebted to **Sri. Dr.S.Uday Kumar, Principal** and HOD of Electrical and Electronics Engineering, GCET for his valuable inputs and sincere support to complete the work.

Specifically, I am grateful to the Management for their constant advocacy and incitement.

Finally, I would again like to thank the entire faculty in the Department and those people who directly or indirectly helped in successful completion of this work.

B.RAMESH BABU,
M.PRADEEP
MANJUL KHARE
POOJA RAANI

Asst.Professor(s),
EEE Department.

Instructions to the students to conduct an experiment:

1. Students are supposed to come to the lab with preparation, proper dress code.
2. Dress code:

   Boys: Shoe & Tuck.

   Girls: Apron & Cut shoe.
3. Don't switch on the power supply without getting your circuit connections verified.
4. Disciplinary action can be taken in the event of mishandling the equipment or switching on the power supply without faculty presence.
5. All the apparatus taken should be returned to the Lab Assistant concerned, before leaving the lab.
6. You have to get both your Observation book and your Record for a particular experiment corrected well before coming to the next experiment.

Guidelines to write your Observation book:

1. Experiment title, Aim, Apparatus, Procedure should be right side.
2. Circuit diagrams, Model graphs, Observations table, Calculations table should be left side.
3. Theoretical and model calculations can be any side as per convenience.
4. Result should always be at the end (i.e. there should be nothing written related to an experiment after its result).
5. You have to write the information for all the experiments in your observation book.
6. You are advised to leave sufficient no of pages between successive experiments in your observation book for the purpose of theoretical and model calculations.

ELECTRICAL ENGINEERING LAB

II B.Tech II SEM ECE (A, B, C& D) -2014-2015.

List of Experiments

1. Verification of KCL & KVL.
2. Series & Parallel resonance-Timing, Resonant frequency, Bandwidth and Q-factor determination for RLC network.
3. Time response of first order RC/RL network for periodic non sinusoidal input-Time constant and steady state error determination.
4. Two port network parameters-Z, Y, ABCD and h-Parameters.
5. Verification of Superposition and Reciprocity theorems.
6. Verification of Maximum Power Transfer theorem.
7. Experimental verification of Thevenin's and Norton's theorems.
8. Magnetization characteristics of D.C. Shunt Generator.
9. Swinburne's Test on a DC Shunt Motor.
10. Brake test on DC a Shunt Motor.

11 OC & SC Tests on a 1-φ Transformer.

12. Load test on a 1- φ Transformer.

Course objectives

The significance of the Electrical Engineering Lab is renowned in the various fields of engineering applications. For an Electrical Engineer, it is obligatory to have the practical ideas about the Electrical Circuits and Machines. By this perspective we have introduced a Laboratory manual cum Observation for Electrical Engineering lab.

The manual uses the plan, cogent and simple language to explain the fundamental aspects of Electrical Circuits and machines in practical. The manual prepared very carefully with our level best. It gives all the steps in executing an experiment.

Expt No: 1

Verification of KVL and KCL.

Aim: To verify Kirchhoff's Voltage Law and Kirchhoff's Current Law theoretically and practically.

Learning Outcomes:

1) Learn how to prototype circuits on a solder less breadboard.
2) Learn how to read resistor codes.
3) Learn how to use a digital multi meter (DMM) to measure DC current and voltage.
4) Verify KVL and KCL for DC circuits incorporating series and parallel resistances.

Apparatus:

S.No	Name of the equipment	Range	Type	Quantity
1.	Voltmeters			
2.	Ammeters			
3.	Multimeter			
4.	Connecting wires			as per need

Circuit Diagram of KVL:

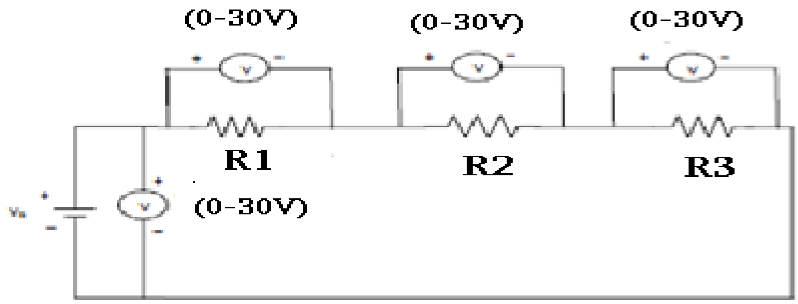


Fig-1

Circuit Diagram of KCL:

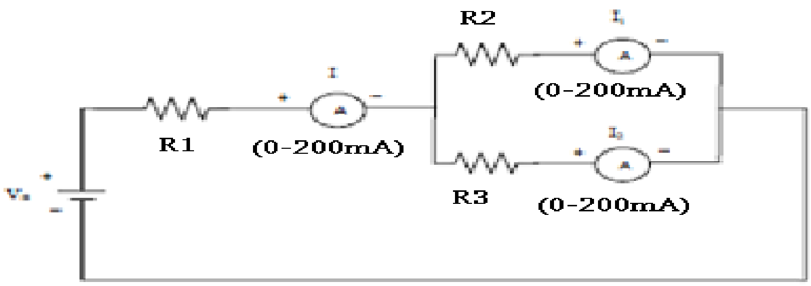


Fig-2

Procedure:

1. To verify KVL, Connections are made as shown in the Fig-1
2. Supply is given to the circuit and the readings of the voltmeters are noted down.
3. Kirchhoff's Voltage law can be verified by $V_s=V_1+V_2+V_3$.
4. To verify KCL, Connections are made as shown in the Fig-2.
5. Supply is given to the circuit and the readings of the Ammeters are noted down.
6. Kirchhoff's Current law can be verified by $I=I_1+I_2$.

Theoretical Calculations:

Observations Table:

	V_s	V_1	V_2	V_3	$V_1+V_2+V_3$		I	I_1	I_2	I_1+I_2
Theoretical Values										
Practical Values										

Precautions:

1. Making loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

Result:

Expt. No: 2

Series and Parallel resonance

Aim: To verify Resonant Frequency, Bandwidth & Quality factor of RLC Series and Parallel Resonant circuits.

Learning outcome: 1.Able to Solve a range of problems in electronic principles using RLC and making use of the underlying concepts and principles

2.Able to implement RLC for tuning radio circ**uit** & Solve problems on series and parallel resonant circuits to find selectivity, bandwidth, half power frequency and resonant frequency.

Apparatus:

S.No	Name of the equipment	Range	Type	Quantity
1.	Multimeter			
2.	Series and parallel resonance kit			
3.	Connecting wires			as per need

Theoretical Calculations:

Formulae Required.

Series Resonance:

1. Resonant frequency, $f_o = \frac{1}{2\pi\sqrt{LC}}$
2. Quality factor, $Q = \frac{X_L}{R} = \frac{2\pi f_o L}{R}$
3. Bandwidth, $BW = \frac{f_o}{Q}$

Parallel Resonance:

1. Resonant frequency, $f_o = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$
2. Quality factor, $Q = \frac{R}{X_L} = \frac{R}{2\pi f_o L}$
3. Bandwidth, $BW = \frac{f_o}{Q}$

Procedure:

Series Resonance:

1. Circuit is connected as shown in the fig (1).

2. A fixed voltage is applied to the circuit through function generator.

3. The frequency is varied in steps and the corresponding ammeter reading is noted down as I_S.

4. A graph is drawn between frequency f and current I_S. Resonant frequency (f_O) and Half power frequencies (f_1, f_2) are marked on the graph.

5. Bandwidth = (f_2-f_1.) & Quality factor $Q = \frac{f_0}{BW}$ are found from the graph.

6. Practical values of Resonant Frequency, Q-factor and Bandwidth are compared with theoretical values.

Parallel Resonance:

1. Circuit is connected as shown in the fig (2)

2. A fixed voltage is applied to the circuit through function generator.

3. The frequency is varied in steps and the corresponding ammeter reading is noted down as I_p.
4. A graph is drawn between frequency f and current I_p. Resonant Frequency (f_o) and Half power frequencies (f_1, f_2) are marked on the graph.
5. Bandwidth = (f_2-f_1.) & Quality factor $Q = \frac{f_0}{BW}$ are found from the graph.
6. Practical values of Resonant Frequency, Q-factor and Bandwidth are compared with theoretical values.

Circuit Diagram of Series Resonance:

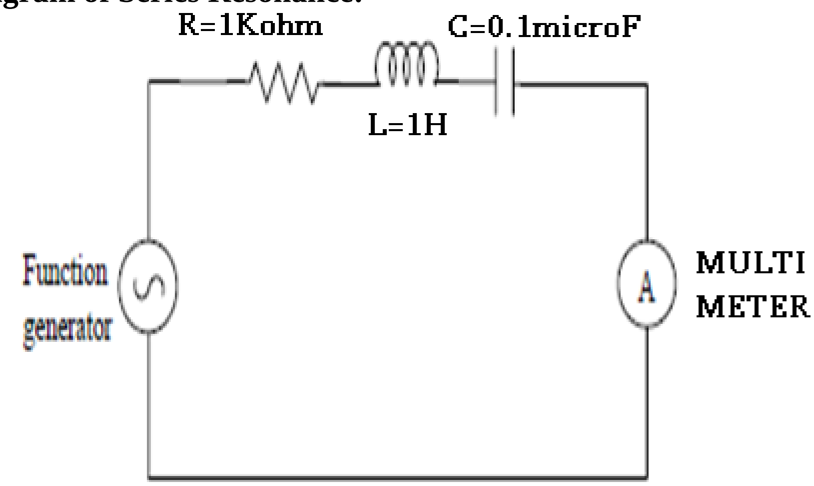
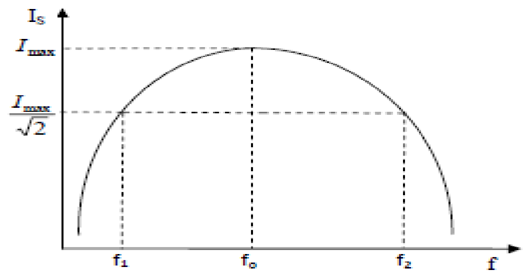


Fig-1

Model Graph:



Circuit Diagram of Parallel Resonance:

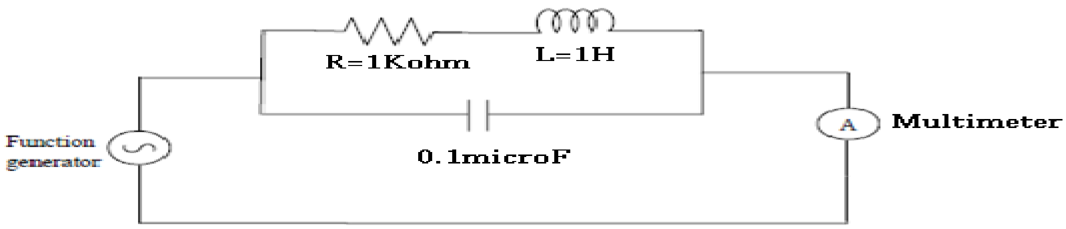
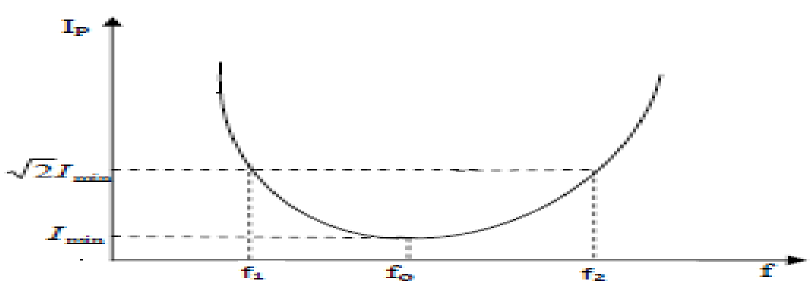


Fig-2

Model Graph



Observations:

Series Resonance

S.No.	Frequency (f)	Current(I_S)

Parallel Resonance

S.No.	Frequency (f)	Current(I_P)

Result Table:

	Series Resonance		Parallel Resonance	
	Theoretical	Practical	Theoretical	Practical
Resonant frequency(f_0)				
Bandwidth(BW)				
Quality factor(Q)				

Precautions:

1. Making loose connections are to be avoided.

2. Readings should be taken carefully without parallax error.

Result:

Expt. No: 3

Time response of Series RL and RC circuits

Aim: To draw the time response of first order series RL and RC network for periodic Non-Sinusoidal function and verify the time constant.

Learning outcomes: 1.Generate and measure the AC steady-state response of a series *RL* circuit.

2. Generate and measure the AC steady-state response of a series *RC* circuit.

Apparatus:

S.No	Name of the equipment	Range	Type	Quantity

1.	Function generator			1
2.	Decade Resistance box			1
3.	Decade Inductance box			1
4.	Decade Capacitance box			1
5.	CRO			1
6.	CRO probes			1
7.	Connecting wires			As required

Theoretical Calculations:

Formulae required:

For RL Series circuit, Time constant, $\tau = \frac{L}{R}$

For RC Series circuit, Time constant, $\tau = RC$

Circuit diagrams:Series RL Circuit

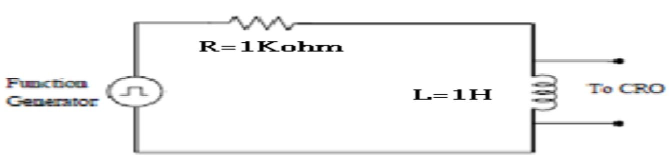


Fig-1

Series RC Circuit

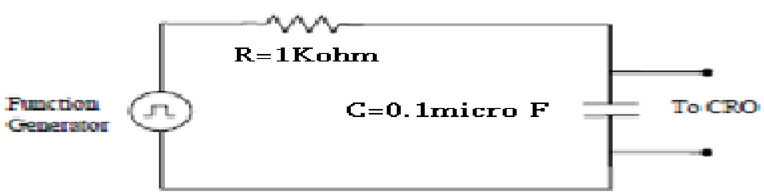
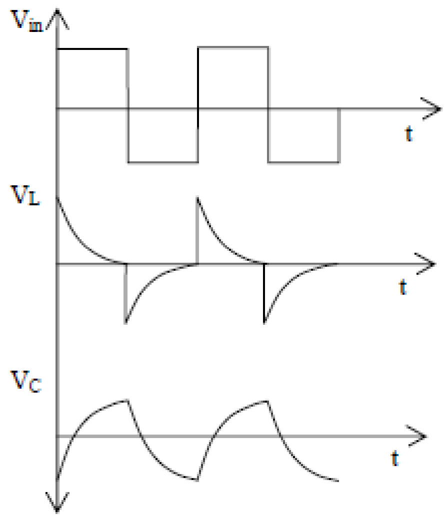


Fig-2

Model Graph



Procedure:

Series RL Circuit:

1. Connections are made as shown in the fig-1.
2. Input voltage (Square wave) is set to a particular value.
3. The waveform of voltage across inductor is observed on CRO and the waveform is drawn on a graph sheet.
4. The time constant is found from the graph and verified with the theoretical value.

Series RC Circuit:

1. Connections are made as shown in the fig-2.
2. Input voltage (Square wave) is set to a particular value.
3. The waveform of voltage across the capacitor is observed on CRO and the waveform is drawn on a graph sheet.
4. The time constant is found from the graph and verified with the theoretical value.

Result table:

.

	Series RL Circuit		Series RC Circuit	
	Theoretical	Practical	Theoretical	Practical
Time Constant(τ)				

Precautions:

1. Making loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

Result:

Expt. No: 4

Two port network parameters (Z, Y, ABCD and Hybrid parameters)

Aim: To obtain experimentally Z , Y, ABCD and h-parameters and of a given two port network.

1. **Learning Outcomes:** Understand Z, Y, ABCD and h-parameters ,their relationships. Will also be able to solve Simple problems on Two-port networks.

Apparatus:

S.No	Name of the equipment	Range	Type	Quantity
1.	Ammeter			
2.	Voltmeter			
3.	Rheostats			
4.	DC Power Supply			
5.	Digital Multimeter			
6.	Connecting wires			as per need

Formulae required:

Z-Parameters:

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$
$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} ; \quad Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$
$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} ; \quad Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

Y-Parameters:

$$I_1 = Y_{11} V_1 + Y_{12} V_2$$
$$I_2 = Y_{21} V_1 + Y_{22} V_2$$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} ; \quad Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$
$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} ; \quad Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

ABCD Parameters:

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

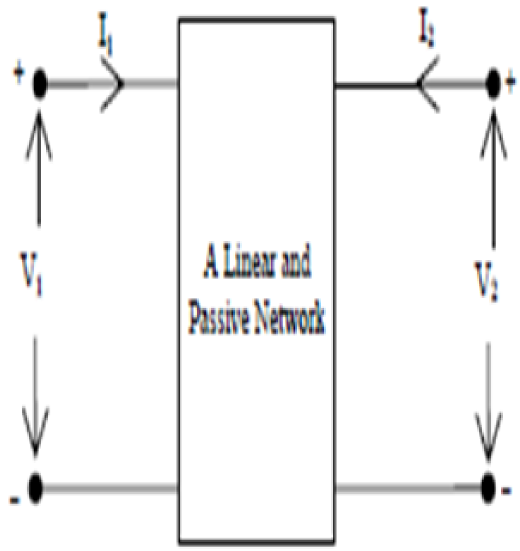
$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0} ; \quad C = \left.\frac{I_1}{V_2}\right|_{I_2=0}$$
$$B = -\left.\frac{V_1}{I_2}\right|_{V_2=0} ; \quad D = -\left.\frac{I_1}{I_2}\right|_{V_2=0}$$

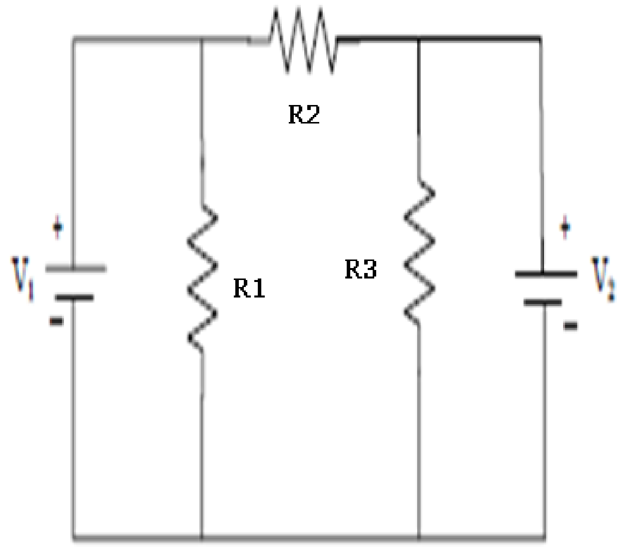
Hybrid or h- Parameters:

$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$

$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} ; \quad h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$
$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0} ; \quad h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0}$$

CIRCUIT DIAGRAMS:





When $I_2 = 0$:

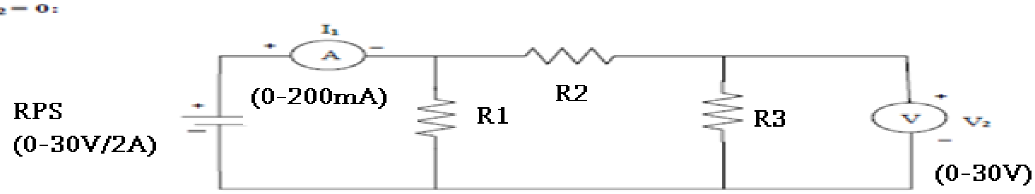


Fig-1

When $V_2 = 0$:

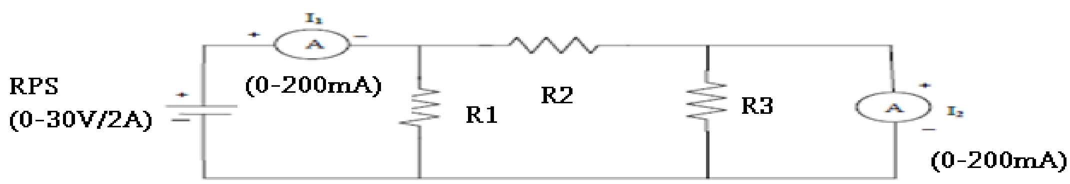


Fig-2

When $I_1 = 0$:

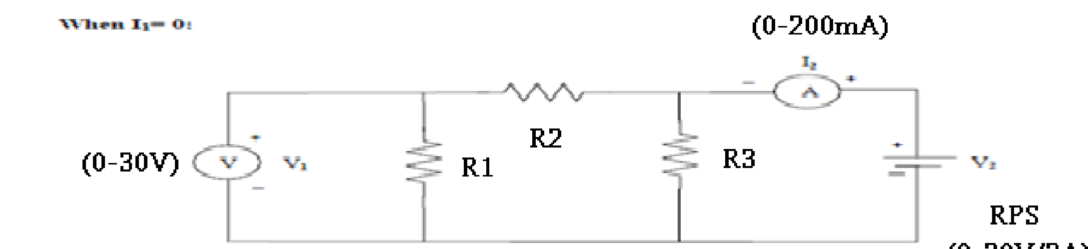


Fig-3

When $V_1 = 0$:

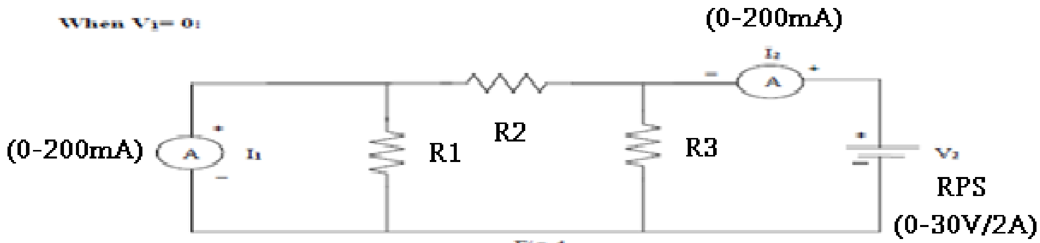


Fig-4

Procedure:

1. Open Circuiting Output Terminals ($I_2 = 0$):

   a) Connections are made shown in fig (1).

   b) Supply is given to input port.

   c) The readings of ammeter as I_1 and Voltmeter as V_2 are noted down.

2. Short circuiting output terminals ($V_2 = 0$):

   a) Connections are made shown in fig (2).

   b) Supply is given to input port.

   c) The readings of ammeters as I_1& I_2 are noted down.

3. Open circuiting input terminals ($I_1 = 0$):

   a) Connections are made shown in fig (3).

   b) Supply is given to output port.

   c) The readings of ammeter as I_1 and Voltmeter as V_1 are noted down.

4. Short circuiting input terminals (V_1=0):

   a) Connections are made shown in fig (4).

   b) Supply is given to output port.

c) The readings of ammeters as I_1 & I_2 are noted down.

5. The Z, Y, ABCD, Hybrid parameters are calculated using formulae and verified with theoretical values.

Observations:

When $I_1=0$

S.No.	V_1	I_2	V_2

When $I_2=0$

S.No.	V_1	I_1	V_2

When $V_1=0$

S.No.	I_2	I_1	V_2

When $V_2=0$

S.No.	V_1	I_1	I_2

Result Table:

	Z Parameters				Y Parameters			
	Z_{11}	Z_{12}	Z_{21}	Z_{22}	Y_{11}	Y_{12}	Y_{21}	Y_{22}
Theoretical								
Practical								

	ABCD Parameters				Hybrid Parameters			
	A	B	C	D	h_{11}	h_{12}	h_{21}	h_{22}
Theoretical								
Practical								

Precautions:

1. Making loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

Result:

Expt No: 5

Superposition theorem and Reciprocity theorems

Aim: To verify Superposition and Reciprocity theorems theoretically and practically.

Learning outcomes: 1.using this theorems student can able to understand practical and theoretical approach using some electrical technique.

2. The objective of this experiment is to study the principles of Super position and reciprocity. This will be accomplished by first analyzing the Particular circuits to be used in this experiment numerically in the preliminary lab Exercise. These same circuits will then be experimentally examined in the lab. The Theoretical and experimental values will then be compared.

Apparatus:

S.No	**Name of the equipment**	**Range**	**Type**	**Quantity**
1.	Ammeter			
2.	Rheostats			
3.	DC Power Supply			
4.	Multimeter		Digital	
5.	Connecting wires			as per need

Theory:

Superposition Theorem Statement

In any linear bilateral network containing two or more energy sources the response at any element is equal to the algebraic sum of the responses caused by the individual sources.

While considering the effect of individual sources, the other ideal voltage sources and ideal current sources in the network are replaced by short circuit and open circuits respectively, across the terminals. This theorem is valid only for linear systems.

Reciprocity Theorem Statement

In any linear bilateral network containing the response at any branch (or) transformation ratio is same even after interchanging the sources.i.e. $V/ I_1 = V/ I_2$

Procedure:

Superposition Theorem:

1. The circuit is connected as shown in fig (1).
2. Both the voltages V_1 and V_2 applied and the current through load resistor is noted as $\mathbf{I_X}$.
3. Supply voltage V_2 is replaced with short circuit and V_1 is applied as shown in fig (2) and the current through load resistor is noted down as $\mathbf{I_Y}$.
4. Supply voltage V_1 is replaced with short circuit and V_2 applied as shown in fig (3) and the current through load resistor is noted down as $\mathbf{I_Z}$.
5. It can be verified that $\mathbf{I_X = I_Y + I_Z}$ theoretically and practically which proves Superposition theorem.

Reciprocity Theorem:

1. The circuit is connected as shown in fig (1).
2. The ammeter reading is noted down as $\mathbf{I_1}$.
3. Now the source and ammeter are interchanged as in fig (2).
4. The ammeter reading is noted down as $\mathbf{I_2}$..
5. It can be veried that $\mathbf{Vs/ I_1 = Vs/ I_2}$ theoretically and practically which proves Reciprocity theorem.

Circuit Diagrams & tabular form of Superposition Theorem:

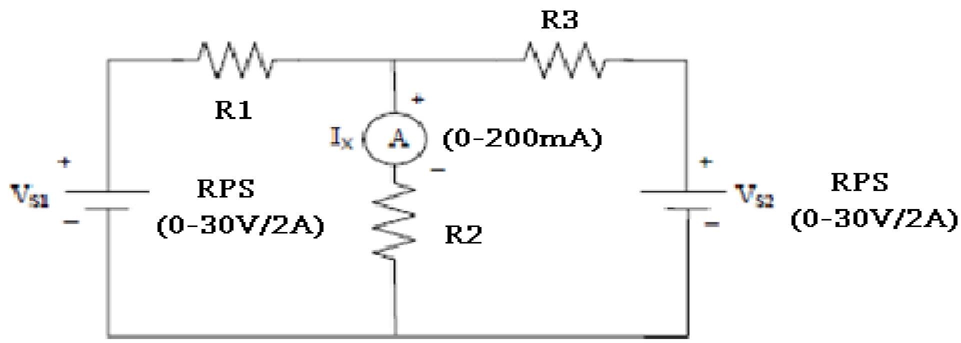


Fig-1

When both the sources are acting: fig (1)

Vs1	Vs2	Theoretical Ix	Practical Ix

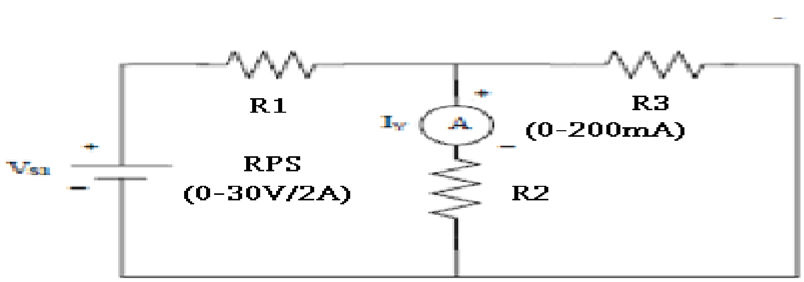


Fig-2

When V_1 source alone is acting: fig (2)

V_{S1}	V_{S2}	Theoretical I_Y	Practical I_Y

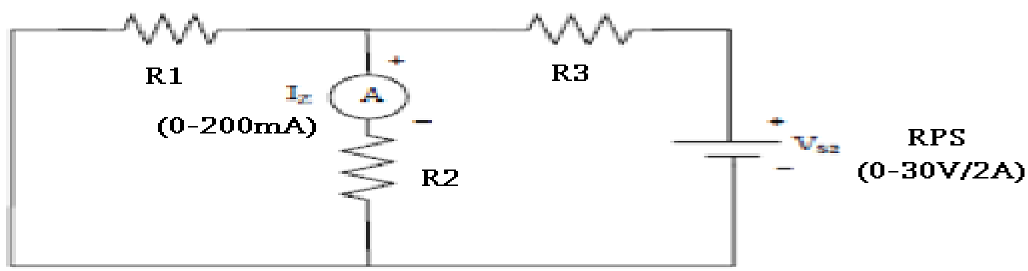


Fig-3

When V_2 source alone is acting: fig (3)

V_{S1}	V_{S2}	Theoretical I_Z	Practical I_Z

Circuit Diagrams & Tabular form of Reciprocity Theorem:

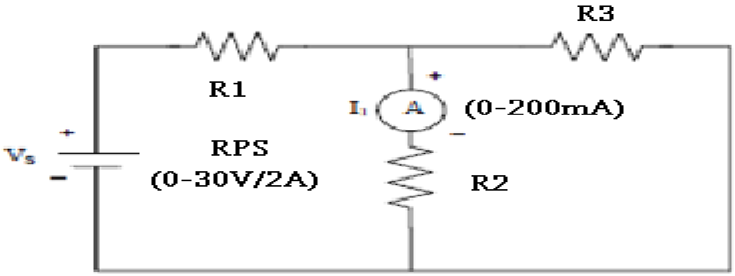


Fig-1

Before interchanging the sources: fig (1)

Vs	Theoretical values		Practical values	
	I_1	V_s/I_1	I_1	V_s/I_1

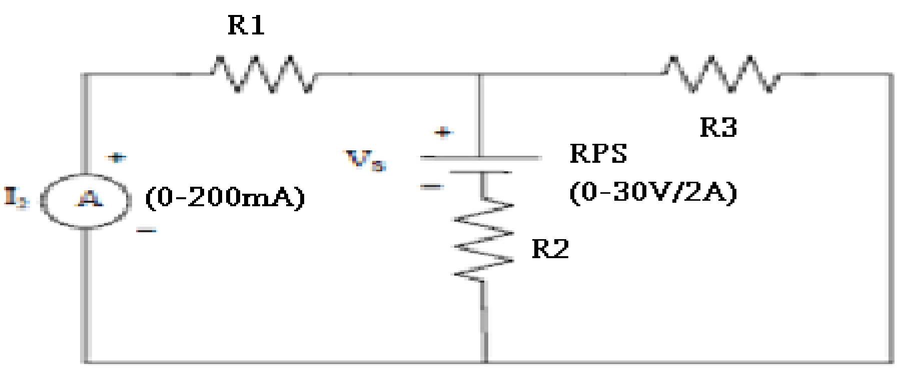


Fig-2

After interchanging the sources: fig (2)

Vs	Theoretical values		Practical values	
	I_2	V_s/I_2	I_2	V_s/I_2

21

Precautions:

1. Making loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

Result:

Expt. No.6

Maximum power transfer theorem

Aim: To verify maximum power transfer theorem on DC with Resistive load theoretically and practically.

Learning outcomes: The objective of this experiment is to study the principles of Maximum Power Transfer Theorem. This will be accomplished by first analyzing the Particular circuits to be used in this experiment numerically in the preliminary lab Exercise. These same circuits will then be experimentally examined in the lab. The Theoretical and experimental values will then be compared.

Apparatus :

S.No	Name of the equipment	Range	Type	Quantity
1.	Ammeter			
2.	Voltmeter			
3.	Rheostats			
4.	DC Power Supply			
5.	Multimeter		Digital	
6.	Double Pole Double Throw Switch			
6.	Connecting wires			as per need

Theorem Statement

It states that the maximum power is transferred from the source to the load, when the load resistance is equal to the source resistance.

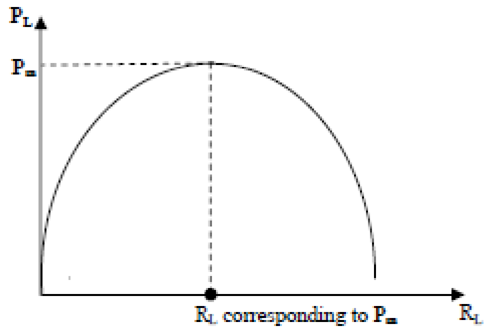
Theoretical Calculations:

Formulae required:

$$\text{Theoretical } I_L = \frac{V_{th}}{R_L + R_{th}}$$

Fig-1

Model Graph:



Procedure:

1. Connections are made as shown in fig (1).
2. $\mathbf{R_L}$ is varied in steps and the reading of ammeter $\mathbf{I_L}$ is noted down in each step.

3. The circuit is connected as shown in fig (2) and the effective resistance $\mathbf{R_{th}}$ is measured with the help of digital multimeter.
4. Power delivered to load $\mathbf{P_L}$ is calculated in each step.
5. A graph is drawn between $\mathbf{P_L}$ Vs $\mathbf{R_L}$ and $\mathbf{R_L}$ corresponding to maximum power is found from it.
6. It can be verified that $\mathbf{R_L}$ corresponding to maximum power from the graph is equal to the $\mathbf{R_{th}}$ (which is nothing but source resistance $\mathbf{R_S}$) which proves the maximum power transfer theorem.

Observations:

Tabular column:

S.No	R_L	Theoretical values		Practical values	
		$I_L = \frac{V_{th}}{R_L + R_{th}}$	$P_L = I_L^2 R_L$	I_L	$P_L = I_L^2 R_L$

Model Calculations:

Precautions:

1. Making loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

Result:

Expt. No.7

Experimental verification of Thevenin's & Norton's theorems

Aim: To verify Thevenin's and Norton's theorems theoretically and practically.

Learning outcomes: The objective of this experiment is to study the principles of Thevenin's Theorem and Norton's Theorem. This will be accomplished by first analyzing the Particular circuits to be used in this experiment numerically in the preliminary lab Exercise. These same circuits will then be experimentally examined in the lab. The Theoretical and experimental values will then be compared.

Apparatus:

S.No	Name of the equipment	Range	Type	Quantity
1.	Ammeter			
2.	Voltmeter			
3.	Rheostats			
4.	DC Power Supply			
5.	Digital Multimeter			
6.	Connecting wires			as per need

Theory:

Statement of Thevenin's Theorem:

Any two terminal linear bilateral network containing of energy sources and impedances can be replaced with an equivalent circuit consisting of voltage source V_{th} in series with an impedance, Z_{th}., where V_{th} is the open circuit voltage between the load terminals and Z_{th} is the equivalent impedance measured between the two terminals with all the energy sources replaced by their internal impedances.

Statement of Norton's Theorem:

Any two terminal linear bilateral network containing of energy sources and impedances can be replaced with an equivalent circuit consisting of a Current source I_N in parallel with an impedance, Z_N., where I_N is the short circuit current across the load terminals and Z_N is the equivalent impedance measured between the two terminals with all the energy sources replaced by their internal impedances.

Circuit Diagrams:

To find I_L:

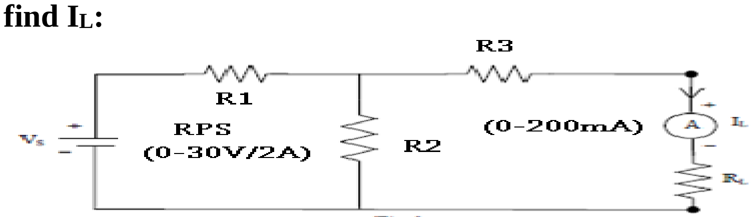


Fig-1

S.NO.	Vs(V)	I_L(mA)

To Find V_{th}:

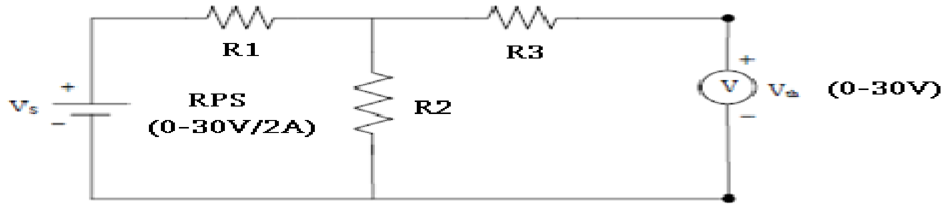


Fig-3

S.NO	V_S(V)	V_{th}(V)

To Find R_{th}:

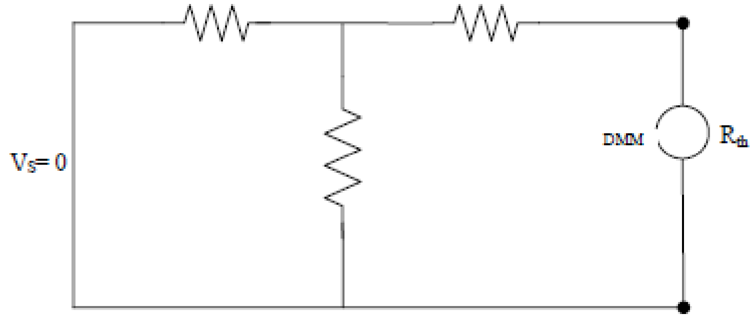


Fig-4

To find I_L^I:

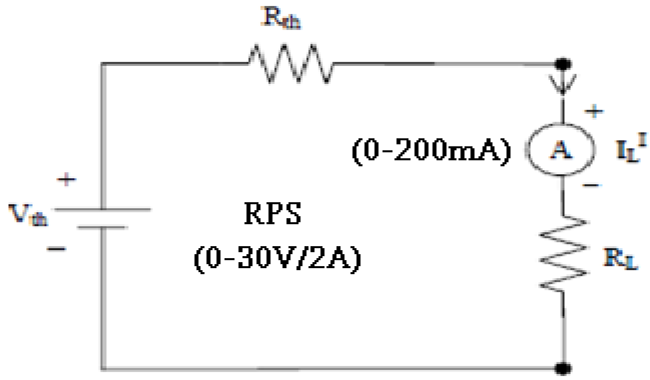


Fig-5

S.NO	V_{th}(V)	I_L^I(mA)

Norton theorem:

To Find I_N:

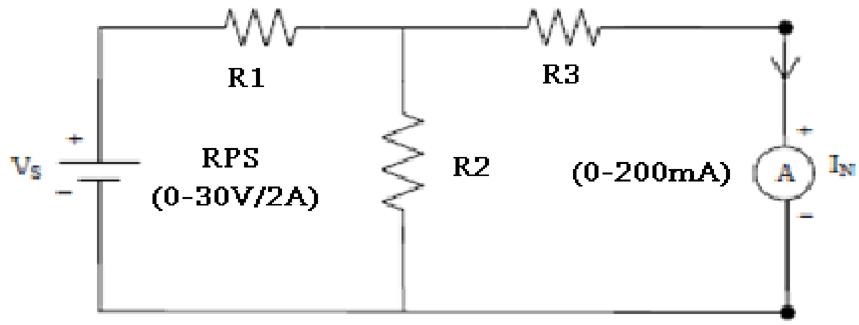


Fig-2

S.NO.	V_S(V)	I_N(mA)

To find I_L^I:

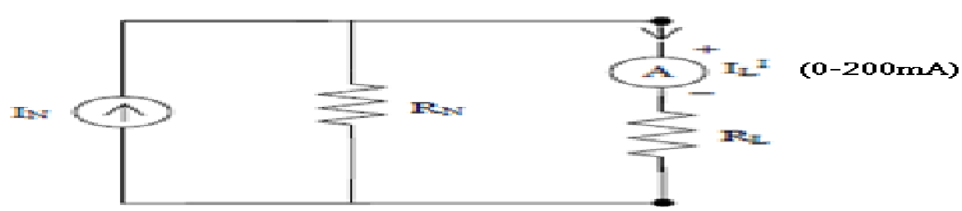


Fig-6

S.NO.	I_N(mA)	I_L^I(mA)

Procedure:

1. Connections are made as per the circuit shown in fig (1).

2. DC voltage is applied to the circuit and the current $\mathbf{I_L}$ flowing through the load is noted down.

3. Circuit is connected as shown in fig (2). DC voltage is applied the reading of Ammeter is noted down as I_N.
4. Circuit is connected as shown in fig (3). DC voltage is applied the reading of Voltmeter is noted down as V_{th}.
5. The circuit is connected as shown in fig (4) and the effective resistance $\mathbf{R_{th}}$ **/** $\mathbf{R_N}$ is measured with the help of a multimeter.
6. Thevenin's equivalent circuit is connected as shown in fig (5) and the ammeter reading is noted down as $\mathbf{I_L^1}$.
7. Thevenin's theorem can be verified by checking that the currents $\mathbf{I_L}$ and $\mathbf{I_L^1}$ are equal.

8. Norton's equivalent circuit is connected as shown in fig (6) and the ammeter reading is noted down as $\mathbf{I_L^1}$.
9. Norton's theorem can be verified by checking that the currents $\mathbf{I_L}$ and $\mathbf{I_L^1}$ are equal.

Precautions:

1. Making loose connections are to be avoided.

2. Readings should be taken carefully without parallax error.

Result:

Expt No: 8

Magnetization Characteristics of DC Shunt Generator

Aim: To conduct an experiment on a D.C Shunt Generator and draw the magnetization characteristics (Open Circuit Characteristics or OCC) and to determine the Critical Field Resistance (R_C) and Critical Speed (N_C).

Learning outcomes: using this test student can able to understand how to calculate the critical resistance and critical speed form the characteristics and how to run the generator used prime mover as motor.

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	400Ω/1.7A	1
4	Tachometer	Digital	-	1

Name plate details:

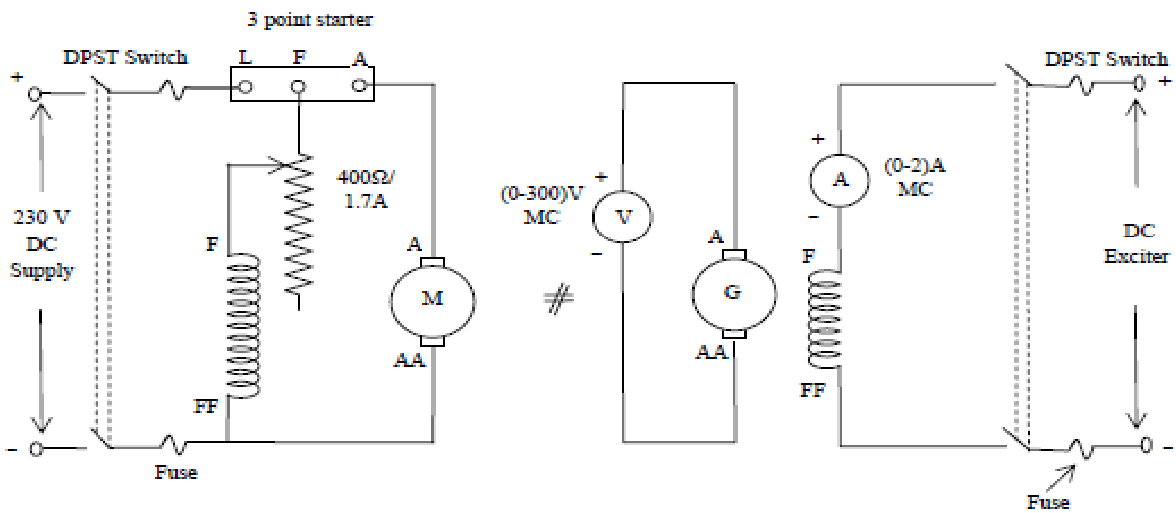
Theory:

Open circuit characteristics or magnetization curve is the graph between the generated emf (E_g) and field current (I_f) of a dc shunt generator. For field current is 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 then the machine can not build up voltage. To obtain residual magnetism the machine is separately excited by a dc source. We can get critical field resistance (R_C) and critical speed (N_C) from OCC.

Critical field resistance: It is the value of field rresistance above which the machine cannot build up emf.

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

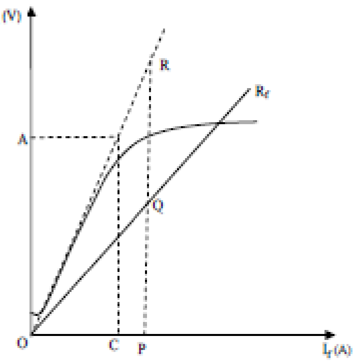
Circuit diagram:



Procedure:

1. Connections are made as per the circuit diagram.
2. Motor is started with the help of Three Point starter and brought to its rated speed by varying the field rheostat.
3. The Eg for I_f =0 is noted and the DPST switch on the DC Exciter side is closed.
4. The DC Exciter is varied in steps and the values of Field current (I_f) and corresponding generated voltage (Eg) are noted down in each step, in both ascending and descending orders.
5. Average Eg is calculated from ascending and descending orders.
6. A graph is drawn between E_g & I_f. From the graph (OCC), Critical field resistance (R_C) and Critical (N_C) speed are calculated.

Model Graph:



Tabular column:

S.No	Field current I_f (A)	Generated Voltage (Eg)		Average Eg (V)
		Ascending order	Descending order	

Calculations:

From the graph:

Critical field Resistance, $R_C = \frac{OA}{OC}$

Critical Speed, $N_C = \frac{PQ}{PR} \times N_{rated}$

Precautions:

1. Loose connections should be avoided.
2. Readings are taken without parallax error.

Result:

Expt No: 9

Swinburne's test

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

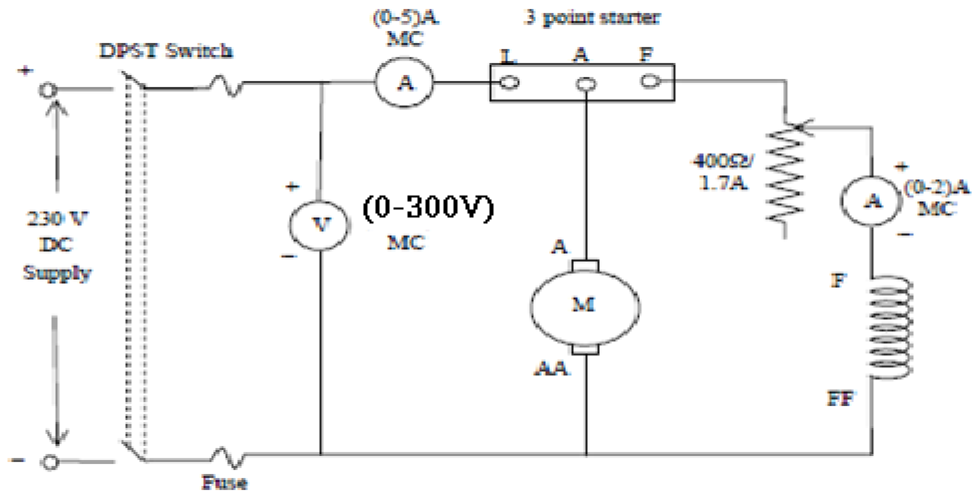
Learning outcomes: using this test student can able to understand how to calculate the efficiency of dc shunt motor as well as dc shunt generator .

Equipment:

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	350Ω/1.7A	1

Name plate details:

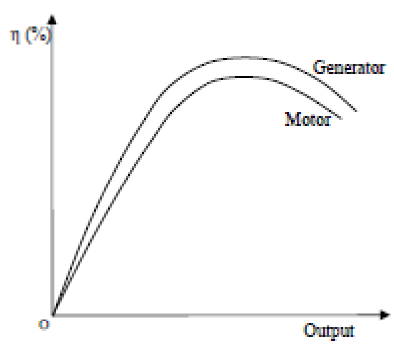
Circuit diagram:



Procedure:

1. Connections as made as per the circuit diagram.
2. Field rheostat is kept in minimum position and the motor is started with the help of 3-Point starter, and is brought to rated speed by adjusting field rheostat.
3. The readings of both ammeters and voltmeter are noted down.
4. The efficiencies of the machine both as a motor and as a generator are calculated.
5. Graphs are drawn between output Vs efficiency for the Machine acting as a generator and as a motor.

Model Graph:



No-Load Test Observation table:

I_{L0}	I_f	V	N

Calculations:

From No-Load Test:

$\text{No-Load input} = VI_{L0} =$

$\text{No-Load Armature current} = I_{L0} - I_f =$

$\text{No-Load Armature Cu loss} = I_{a0}^2 R_a =$

$\text{Constant loss, } W_C = \text{No-load input} - \text{No-load Armature Cu loss} = VI_{L0} - I_{a0}^2 R_a =$

$\therefore W_C =$

Machine acting as Generator: V=230V, WC = , R_a= , I_f = .

S.No	Voltage, V (Volts)	Load current, I_L (A)	Output, $P_{out} = VI_L$	Armature Current, $I_a = I_L + I_f$	Armature Cu Loss $I_a^2 R_a$	Total Loss, $W_T = W_C + I_a^2 R_a$	Input, $P_{in} = P_{out} + W_T$	Efficiency (%), $\eta = \frac{P_{out}}{P_{in}} \times 100$

Machine acting as Motor: : V=230V, WC = , R_a= , I_f = .

S.No	Voltage, V (Volts)	Load current, I_L (A)	Input, $P_{in} = VI_L$	Armature Current, $I_a = I_L - I_f$	Armature Cu Loss $I_a^2 R_a$	Total Loss, $W_T = W_C + I_a^2 R_a$	Output, $P_{out} = P_{in} - W_T$	Efficiency (%), $\eta = \frac{P_{out}}{P_{in}} \times 100$

Model calculation:

To Predetermine the Efficiency as a Motor:

Let I_L=

$$\text{Motor input} = VI_L =$$

$$\text{Total loss} = W_C + I_a^2 R_a = W_C + (I_L - I_f)^2 R_a =$$

$$\text{Motor Output} = \text{Motor input} - \text{Total loss} =$$

$$\therefore \text{Efficiency, } \eta = \frac{\text{Output}}{\text{Input}} \times 100 =$$

To Predetermine the Efficiency as a Generator:

Let I_L=

$$\text{Generator Output} = VI_L =$$

$$\text{Total loss} = W_C + I_a^2 R_a = W_C + (I_L + I_f)^2 R_a =$$

$$\text{Generator Input} = \text{Generator output} + \text{Total loss} =$$

$$\therefore \text{Efficiency, } \eta = \frac{\text{Output}}{\text{Input}} \times 100 =$$

Precautions:

1. Loose connections should be avoided.
2. Readings are taken without parallax error.

Result:

Expt No: 10

Brake test on a DC Shunt motor

Aim: To conduct Brake test on a DC Shunt motor. And to draw its performance curves.

Learning outcomes: using this test student can able to understand how to calculate the efficiency of dc shunt motor and how to vary the speed corresponding load.

Apparatus:

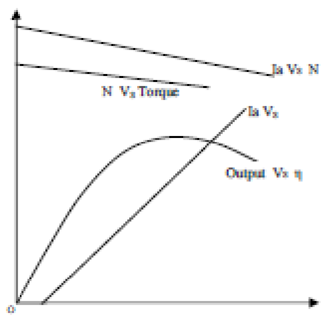
S. No	Equipment	Range	Type	Qty
1.	Voltmeter	0-250V	M.C.	1
2.	Ammeter	0-20A	M.C	1
3	Ammeter	0-1/2A	M.C	1
4	Rheostat	400Ω/1.7A	Wire wound	1
5.	Tachometer		Digital type	1

6.	Connecting wires			

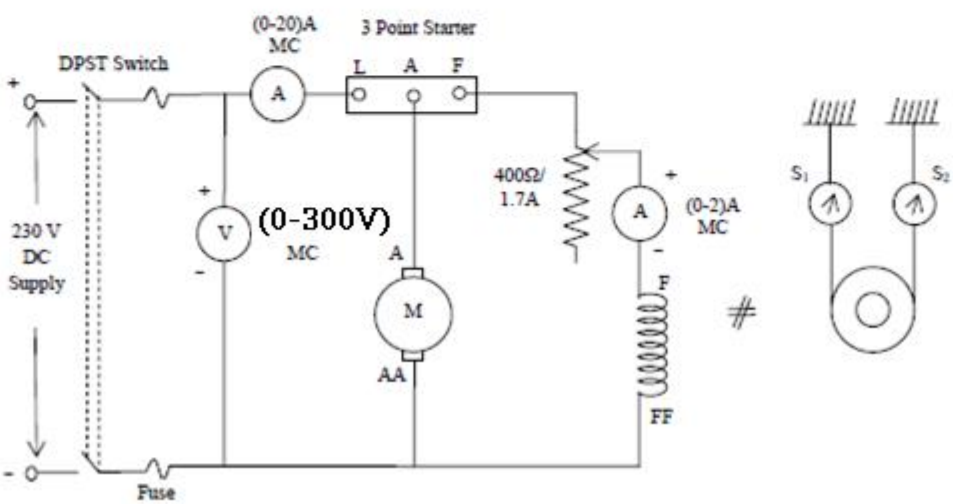
Name plate details:
Procedure:

1. Connections are made as shown in the circuit diagram.
2. Field rheostat is kept in minimum position and the motor is started with the help of 3-Point starter, and is brought to rated speed by adjusting field rheostat.
3. By varying the load in steps, readings of ammeters, voltmeter, tachometer, spring balances, are noted down.
4. Performance curves are to be drawn after completing the calculations.

Model graph:



Circuit diagram:



Calculations Table: r = .

S.No	Voltage, V (Volts)	Line current, I_L (A)	Speed, N (rpm)	Spring balance readings (Kgs) S_1	S_2	Torque, $T=9.81\times(S_1 \sim S_2)\times r$ (N-m)	Output, $P_{out}=\frac{2\Pi NT}{60}$	Input, $P_{in}=VI_L$	Efficiency (%), $\eta=\frac{P_{out}}{P_{in}}\times 100$

Precautions:

1. Loose connections should be avoided.
2. Readings are taken without parallax error.

Result:

Expt No: 11

OC & SC tests on 1-φ transformer

Aim: To conduct OC & SC tests on the given 1-Φ Transformer and to calculate its equivalent circuit parameters and predetermine its Efficiency & Regulation.

Learning outcomes: using this test student can able to understand practical how to work the transformer and clearly they will get how to identify the winding on the transformers and from practical data the are able to design the equivalent circuit parameters.

Name plate details:

1-φ TRANSFORMER	
Capacity	3KVA
I/P voltage	115V

.

I/P current	26A
O/P voltage	230V
O/P current	13A
Frequency	50Hz

Apparatus required:

S.No	Apparatus	Range	Type	Qty
1	Voltmeters	0-150V, 0-75V	M.I	1, 1 No
2	Ammeters	0-2A, 0-15A	M.I	1, No
3	Wattmeter	2A, 150V, 60W, LPF 15A, 50V, 600W, UPF	Dynamo meter	1, 1 No
4	Auto T/F	230V/0-270V	1-φ wire wound	1 No

Procedure:

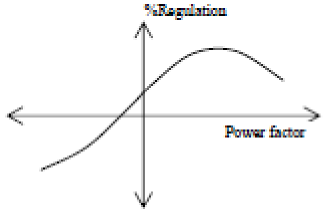
OC Test:

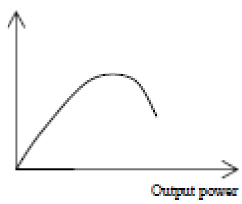
1. Connections are done as per the circuit diagram.
2. Supply is switched on and rated voltage is applied to the LV side by varying the Auto transformer.
3. The readings of Ammeter, Voltmeter & Wattmeter are noted down.

SC Test:

1. Connections are done as per the circuit diagram.
2. Supply is Switched on and rated current is set through the HV winding by varying the Auto transformer.
3. The readings of Ammeter, Voltmeter & Wattmeter are noted down.

Model graphs:





OC test circuit diagram

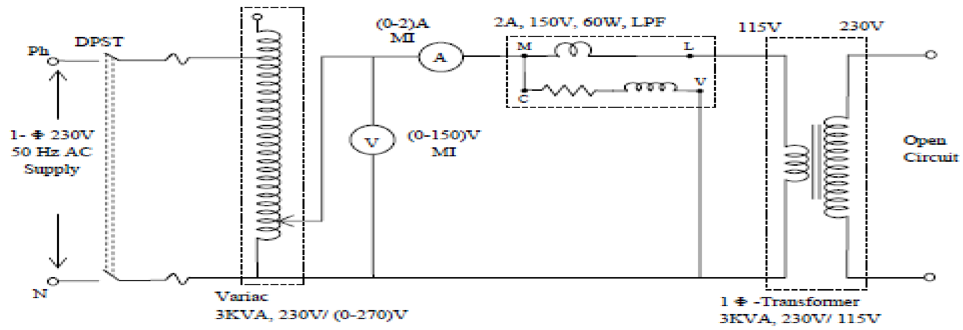


Fig -1

SC test circuit diagram

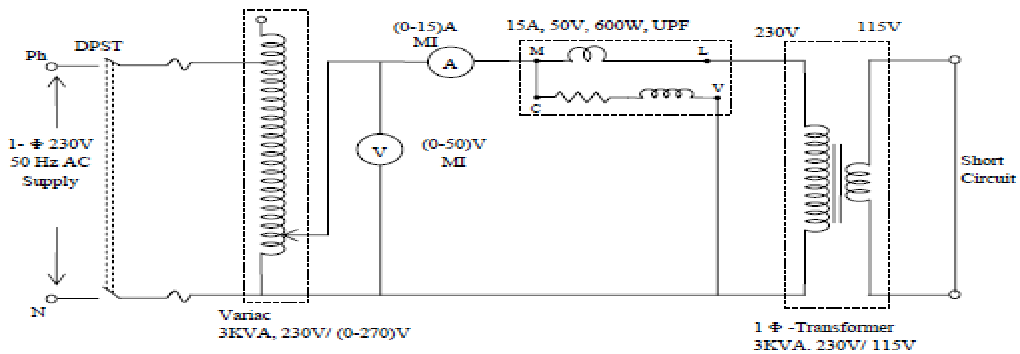


Fig -2

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Observations:

O.C test:

V_0	I_0	W_0

S.C test:

V_{SC}	I_{SC}	W_{SC}

Calculations:

$Cos\phi_0 = \frac{W_0}{V_0 I_0} =$

$I_W = I_0 Cos\phi_0 =$

$I_m = I_0 Sin\phi_0 =$

$R_0 = \frac{V_0}{I_W} =$

$X_m = \frac{V_0}{I_m} =$

Note: The Transformer is taken as step up Transformer.

$R_{02} = \frac{W_{sc}}{I_{sc}{}^2} =$

$Z_{02} = \frac{V_{sc}}{I_{sc}} =$

$X_{02} = \sqrt{Z_{02}{}^2 - R_{02}{}^2} =$

$K = \frac{N_2}{N_1} = \frac{E_2}{E_1} =$

$X_{01} = \frac{X_{02}}{K^2} =$; $R_{01} = \frac{R_{02}}{K^2} =$

$Efficency = \frac{xV_2I_2Cos\theta_2}{xV_2I_2Cos\theta_2 + W_i + W_{sc}} \times 100$

Where, x = Fraction of Full load current

W_i = Iron losss $= W_o$, W_{sc} = Cu loss $= x^2 W_{sc}$

$\%Regulation = \frac{I_2R_{02}Cos\theta_2 \pm I_2X_{02}Sin\theta_2}{V_2} \times 100$

(+ for Lag pf, − for Lead pf)

Where, $Cos\theta_2$ = Load pf

Calculations Table:

Predetermination of Efficiency:

I_2= 13A ; V_2= 230V ; R_{02}= ; W_i= ; Let $Cos\theta_2$=0.8

Load	Cu losses $W_{Cu} = x^2 W_{sc}$	Total Losses $W_T = W_i + W_{SC}$	O/P power $= xV_2I_2Cos\theta_2$	I/P power $= Output + W_T$	η (%) $= \frac{P_{Output}}{P_{Input}} \times 100$
x=0.1					
¼Full load(x=0.25)					
½ Full Load(x=0.5)					
¾ Full Load(x=0.75)					
Full Load(x=1)					

Predetermination of Regulation:

I_2= 13A ; V_2= 230V ; R_{02}= ; X_{02}=

Load pf	% Regulation	
	lag	lead
0.6		
0.7		
0.8		
0.9		
1		

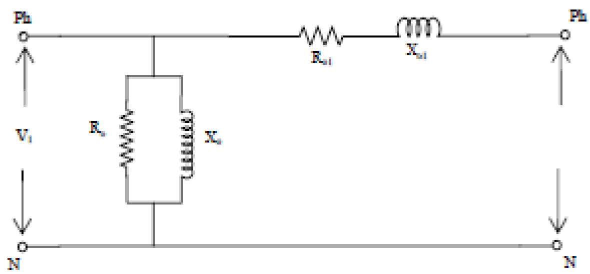
$$\%\,Regulation = \frac{I_2 R_{02} Cos\theta \pm I_2 X_{02} Sin\theta}{V_2} \times 100$$

$(+\ for\ Lag\ pf, -\ for\ Lead\ pf)$

$Where,\ Cos\theta = Load\ pf$

Equivalent Circuit:

Considering the Step up transformer and Referred to LV side.



Model Calculations:

Precautions:

1) The Dimmer stat should be kept at minimum O/P position initially.
2) In OC test, rated voltage should be applied to the Primary of the Transformer.
3) In SC test, the Dimmer stat should be varied up to the rated load current only.
4) The Dimmer stat should be varied slowly & uniformly.

Result:

Expt No: 12

Load test on a 1-φ transformer

Aim: To conduct Load test on the given 1-Φ Transformer and to calculate its, Efficiency & Regulation.

Learning outcomes: using this test student can able to understand practical how to work the transformer and clearly they will get how to identify the winding on the transformers and from practical data the are able to design the equivalent circuit parameters.

Name plate details:

1-φ TRANSFORMER	
Capacity	3KVA
I/P voltage	115V
I/P current	26A
O/P voltage	230V
O/P current	13A
Frequency	50Hz

Apparatus required:

S.No	Apparatus	Range	Type	Qty
1	Voltmeters	0-150V, 0-75V	M.I	1, 1 No
2	Ammeters	0-2A, 0-15A	M.I	1, No
3	Wattmeter	2A, 150V, 60W, LPF 15A, 50V, 600W, UPF	Dynamo meter	1, 1 No
4	Auto T/F	230V/0-270V	1-φ wire wound	1 No

Procedure:

1. Connections are made as per the circuit diagram.
2. By varying the Auto transformer, rated voltage is applied to the input side of the transformer and should be maintained constant throughout the experiment.
3. By varying the load in steps, readings of ammeter, voltmeter, and wattmeter are noted down in each step.
4. Efficiency and Regulations are calculated in each step and tabulated.
5. Graphs are drawn Output Vs Efficiency and

Circuit Diagram

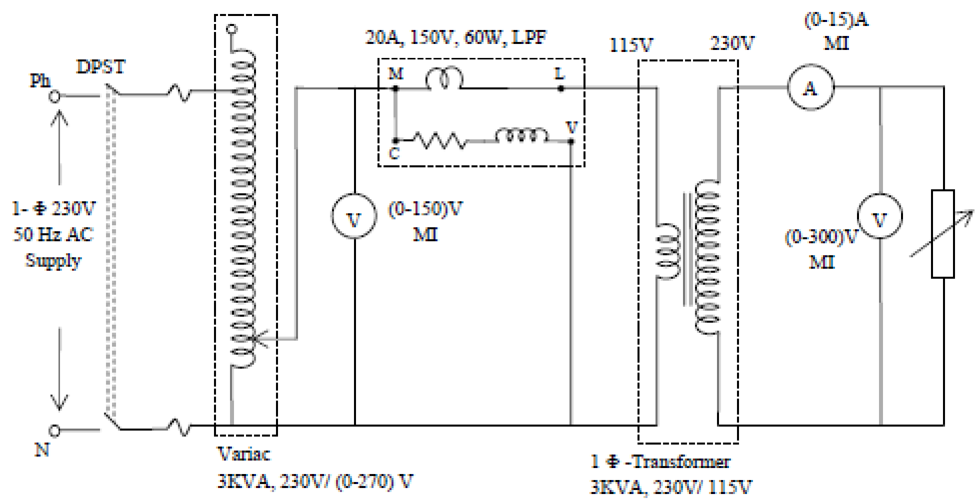


Fig -1

Calculations table:
Rated Secondary Voltage, V_2=230V

S.No	Secondary Voltage V_2^I (V)	Secondary Current, I_2(A)	Input Power (Watts)(wattmeter reading)	Output Power $=V_2xI_2$ (Watts)	*Efficiency* $\eta=\frac{P_{Output}}{P_{Input}}\times 100$	% Re *gulation* $=\frac{V_2-V_2^I}{V_2}\times 100$

Precautions:

1. The Dimmer stat should be kept at minimum O/P position initially.
2. Rated voltage should be maintained on the Primary of the Transformer.
3. The Dimmer stat should be varied slowly & uniformly.

Result:

Important Viva-voce questions:

1. What is the principle of operation of a DC Generator?

2. What are the main parts of a DC Generator and their functions?

3. What is the function of a DC Generator?

4. What are the different types of a DC Generator?

5. What is the principle of operation of a DC Motor?

6. What is the function of a DC Motor?

7. What are the different types of a DC Motor?

8. What is the purpose of a Three point starter?

9. What is the purpose of a fuse?

10. Why the field rheostat should be kept in minimum position?

11. What is the purpose of changing the voltage level in AC Transmission?

12. What is the principle of operation of a Transformer?

13. What is the function of a Transformer?

14. What are the different types of a Transformer?

15. What are the different parts of a Transformer?

16. What are the different types of measuring instruments?

17. What is meant by "Pre determination" with respect to electrical machines?

18. What is meant by efficiency and regulation?

19. Can we start the motor without using three point starter? If so, how?

20. What is the purpose of Auto transformer(or Dimmerstat)?

Note: In addition to the above, students are supposed to know the basic theory and things related for the conduct of a particular experiment.