



SIMATS SCHOOL OF ENGINEERING
SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES
CHENNAI-602105



MASTER RECORD

EEA01 – BASIC ELECTRICAL AND ELECTRONICS ENGINEERING



DO'S AND DON'T'S

DO'S

1. Follow the dress code strictly.
2. Be thorough with the experiment procedure. Identify the different leads or terminals or pins of the component before making connections
3. Know the biasing voltage required for different families of components and connect the power supply voltage and ground terminals to the respective pins.
4. Come with the completed observation and record notebook.
5. Maintain discipline in the lab at all times.
6. Enter the details in the components register before the start of the lab exercise.
7. Students should handle all the equipment carefully.
8. Report any breakage or damage to the Lab -in-charge immediately.
9. Get the signature in the observation from the faculty before proceeding to the experiment
10. Return the components after the completion of the experiments before leaving the lab.
11. Keep the lab neat and switch off the fans and lights when not in use.
12. Do not eat food in the laboratory.
13. Be present in the lab at the scheduled time.

DONT'S

1. Avoid loose connections and short circuits
2. Do not exceed the voltage rating of component
3. Don't move inside the lab without permission and interchange the equipment.
4. Don't cut and throw connecting wires and waste papers in the lab unnecessarily.
5. Don't leave the lab without arranging the chairs and cleaning the work station.
6. Don't manipulate the readings.
7. Protect yourself from getting electric shock.

LIST OF EXPERIMENTS

1. Verification of Ohm's law & Kirchhoff's law.
2. Calculate the individual branch currents and total current drawn from the power supply for the following set of resistors connected together in a parallel using current and voltage division rules.
3. Verification of star-delta transformation using resistance reduction technique.
4. Verification of Thevenin's and Norton's Theorems.
5. Verification of Superposition and Maximum power transfer Theorems.
6. Load test on Single Phase Transformer.
7. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
8. Calculation of Secondary turns and Current in a transformer.
9. Load test on Single phase Induction Motor.
10. To determine the output characteristics of LVDT and calibrate the measuring instruments.
11. Power measurement using two wattmeter methods.
12. Calculate the energy consumption using the Energy meter.
13. Load test on DC shunt Motor.
14. Staircase Wiring & Fluorescent tube wiring
15. Find Stability of a System Using Routh Hurwitz Criterion.
16. Investigating the Performance of Three-Phase Induction Motor Drive Systems in Electric Vehicle Applications.
17. Write SCILAB program to generate the following signals:
 - (a) Unit step signal
 - (b) Unit Impulse signal
 - (c) Unit ramp signal
 - (d) Sinusoidal signal
 - (e) Exponential signal
18. Write a SCILAB program to obtain the following:
 - (a) DIT-FFT Algorithm
 - (b) DIF-FFT Algorithm
19. Design a filter using the Transformation Method.

- (a) Bilinear Transformation
 - (b) Impulse Invariant Transformation
20. Write the SCILAB program to design the following Butterworth filters
- (a) Low pass filter
 - (b) High pass filter
 - (c) Band pass filter
 - (d) Band reject filter.

Expt. No.1	Verification of Ohm's law & Kirchhoff's law
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1. (a) Verification of Ohm's law

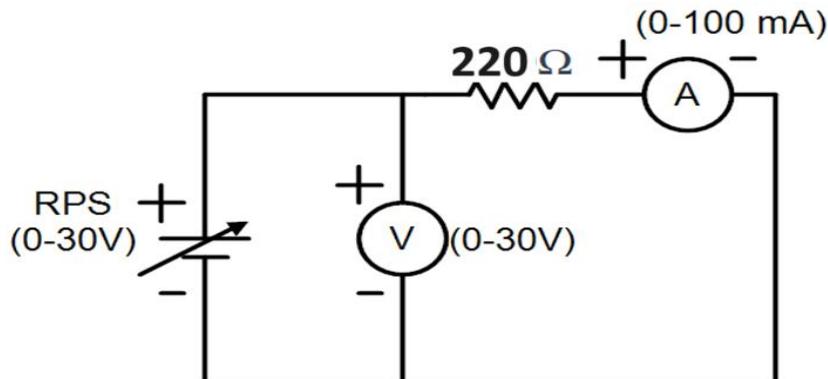
AIM:

To verify Ohm's law for a given resistive network.

APPARATUS REQUIRED:

S.No.	Apparatus Name	Range	Quantity
1	RPS	(0-30)V	1
2	Ammeter	(0-200)mA	1
3	Voltmeter	(0-30)V	1
4	Resistor	1KΩ	1
5	Rheostat	300Ω/2A	1
6	Bread board & Connecting wires	--	Required

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the connections as per circuit diagram.
2. Switch ON the power supply to RPS and apply a voltage (say 10V) and take the reading of voltmeter and ammeter.
3. Adjust the rheostat in steps and take down the readings of ammeter and voltmeter.
4. Plot a graph with V along x-axis and I along y-axis.
5. The graph will be a straight line which verifies Ohm's law.
6. Determine the slope of the V-I graph. The reciprocal of the slope gives resistance of the wire.

OBSERVATIONS:

S.No.	Voltage (V)	Current (mA)	Experimental Value $R = V/I \text{ in } \Omega$	Theoretical Value $R = V/I \text{ in } \Omega$
1.	1	5	200	220
2.	2	10	200	220
3.	3	16	187.5	220
4.	4	20	200	220
5.	5	24	208.3	220
6.	6	28	214.28	220
7.	7	32	218.75	220

THEORETICAL CALCULATIONS

1. $V=IR$

$$I = \frac{V}{R} = \frac{1}{220} = 4.5454mA$$

$$R = \frac{V}{I} = \frac{1}{4.5454 \times 10^{-3}} = 220\Omega$$

$$2. I = \frac{V}{R} = \frac{2}{220} = 9.0909mA$$

$$R = \frac{V}{I} = \frac{2}{9.0909 \times 10^{-3}} = 220\Omega$$

$$3. I = \frac{V}{R} = \frac{3}{220} = 13.6363mA$$

$$R = \frac{V}{I} = \frac{3}{13.6363 \times 10^{-3}} = 220\Omega$$

$$4. I = \frac{V}{R} = \frac{4}{220} = 18.1818mA$$

$$R = \frac{V}{I} = \frac{4}{18.1818 \times 10^{-3}} = 220\Omega$$

$$5. I = \frac{V}{R} = \frac{5}{220} = 22.7272mA$$

$$R = \frac{V}{I} = \frac{5}{22.7272 \times 10^{-3}} = 220\Omega$$

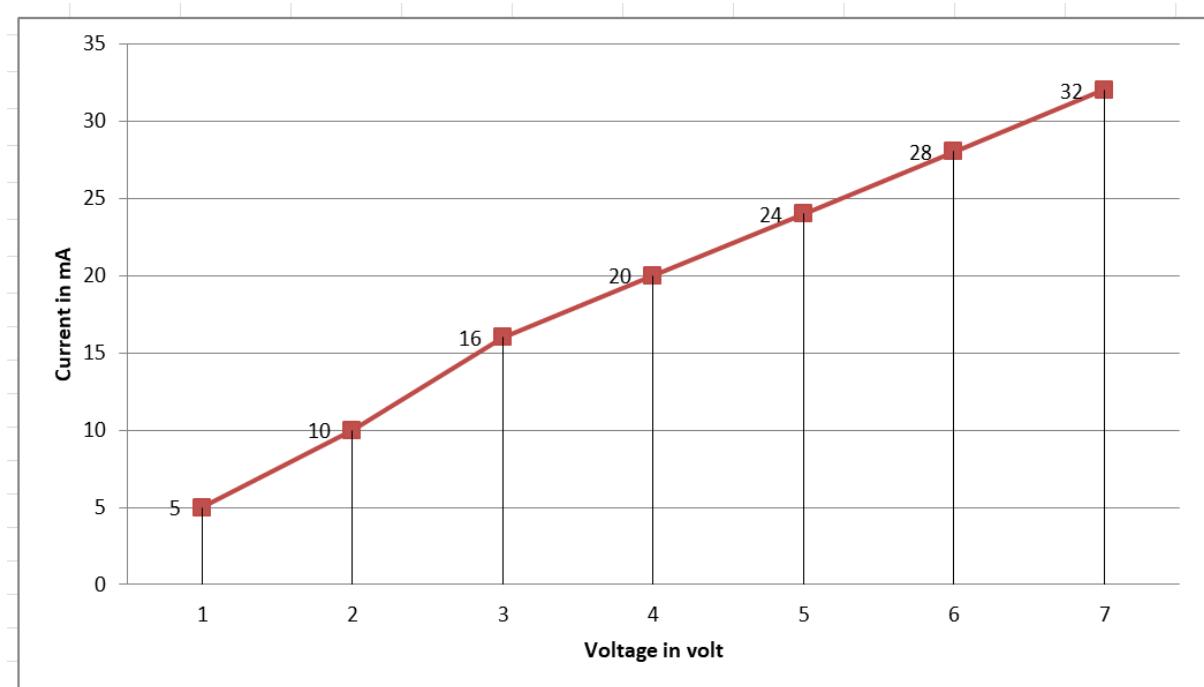
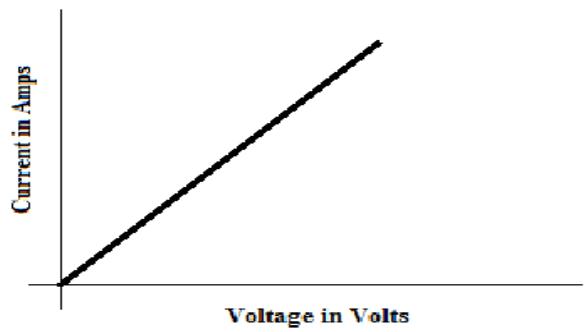
$$6. I = \frac{V}{R} = \frac{6}{220} = 27.2727mA$$

$$R = \frac{V}{I} = \frac{6}{27.2727 \times 10^{-3}} = 220\Omega$$

$$7. I = \frac{V}{R} = \frac{7}{220} = 31.8181mA$$

$$R = \frac{V}{I} = \frac{7}{31.8181 \times 10^{-3}} = 220\Omega$$

MODEL GRAPH:



Marks Obtained:

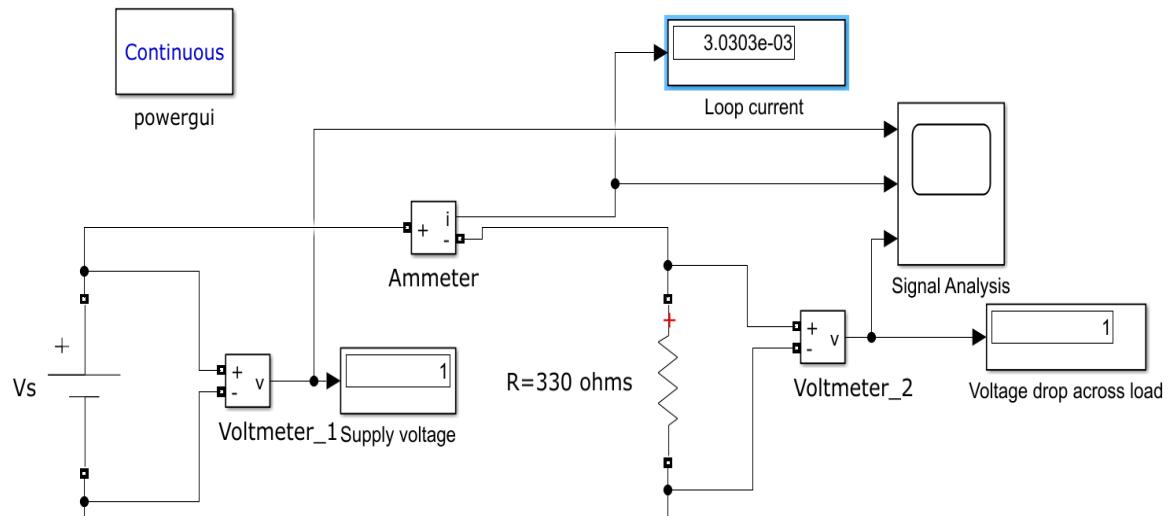
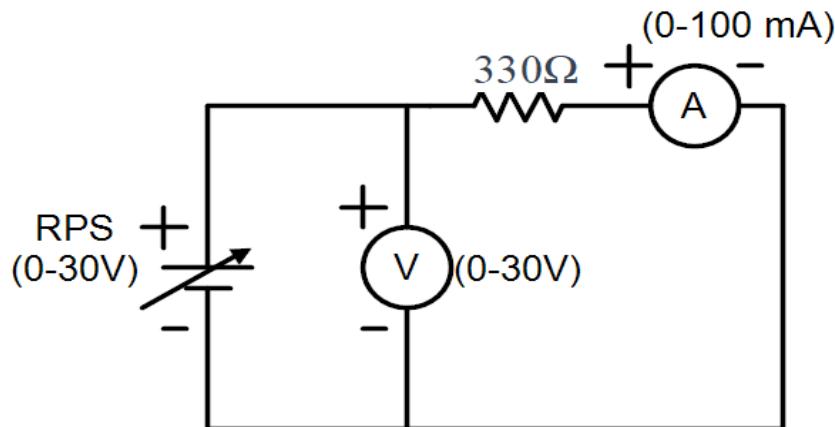
Theoretical Calculations	20	
Observation	20	
Execution of practice examples	30	
Viva	10	
Record	20	
Total Score	100	
Date of experiment		
Date of record submission		Faculty signature

RESULT:

Thus the Ohm's law is verified for the given circuit.

Test case 1:

Conduct a simulation to verify Ohm's law with a relevant circuit using matlab Simulink.



Tabulations:

S.No.	Voltage (V)	Current (mA)	Simulation Value $R = V/I$ in Ω	Theoretical Value $R = V/I$ in Ω
1.	1	3.0303	330	330
2.	2	6.0606	330	330
3.	3	9.0909	330	330
4.	4	12.1212	330	330
5.	5	15.1515	330	330
6.	6	18.1818	330	330
7.	7	21.2121	330	330

THEORETICAL CALCULATIONS

1. $V=IR$

$$I = \frac{V}{R} = \frac{1}{330} = 3.0303mA$$

$$R = \frac{V}{I} = \frac{1}{3.0303 \times 10^{-3}} = 330\Omega$$

$$2. I = \frac{V}{R} = \frac{2}{330} = 6.0606mA$$

$$R = \frac{V}{I} = \frac{2}{6.0606 \times 10^{-3}} = 330\Omega$$

$$3. I = \frac{V}{R} = \frac{3}{330} = 9.0909mA$$

$$R = \frac{V}{I} = \frac{3}{9.0909 \times 10^{-3}} = 330\Omega$$

$$4. I = \frac{V}{R} = \frac{4}{330} = 12.1212mA$$

$$R = \frac{V}{I} = \frac{4}{12.1212 \times 10^{-3}} = 330\Omega$$

$$5. I = \frac{V}{R} = \frac{5}{330} = 15.1515mA$$

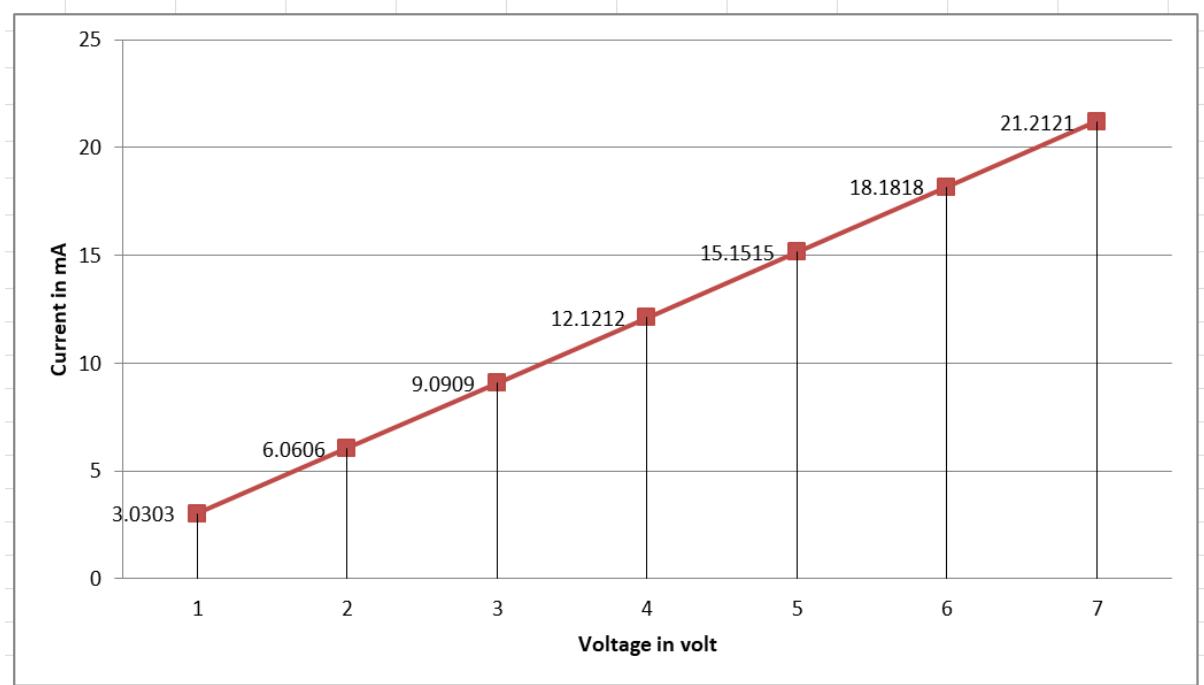
$$R = \frac{V}{I} = \frac{5}{15.1515 \times 10^{-3}} = 330\Omega$$

$$6. I = \frac{V}{R} = \frac{6}{330} = 18.1818mA$$

$$R = \frac{V}{I} = \frac{6}{18.1818 \times 10^{-3}} = 330\Omega$$

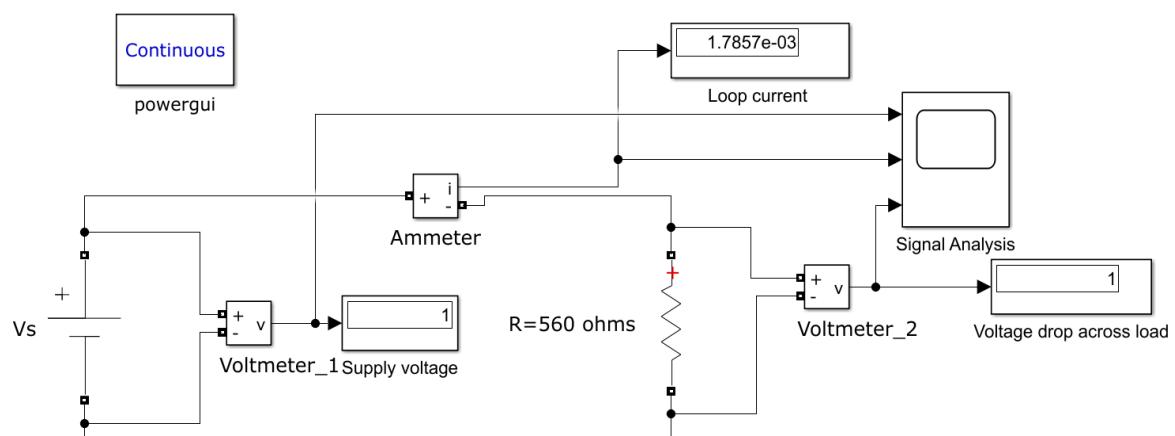
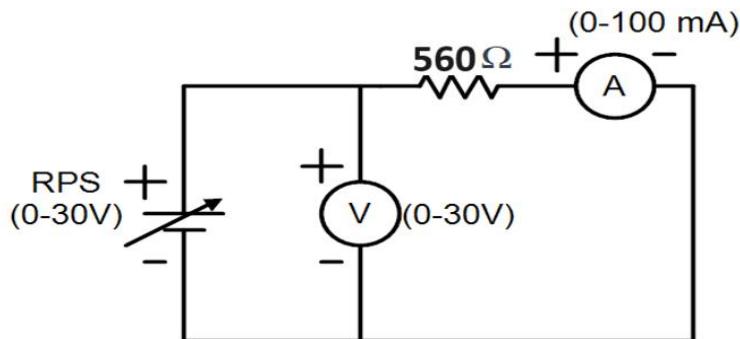
$$7. I = \frac{V}{R} = \frac{7}{330} = 21.2121mA$$

$$R = \frac{V}{I} = \frac{7}{21.2121 \times 10^{-3}} = 330\Omega$$



Test case 2:

Conduct a simulation to verify Ohm's law with a relevant circuit using matlab Simulink.



Tabulations:

S.No.	Voltage (V)	Current (mA)	Simulation Value $R = V/I$ in Ω	Theoretical Value $R = V/I$ in Ω
1.	1	1.7857	560	560
2.	2	3.5714	560	560
3.	3	5.3571	560	560
4.	4	7.1429	560	560
5.	5	8.9286	560	560
6.	6	10.7143	560	560
7.	7	12.5	560	560

THEORETICAL CALCULATIONS

1. $V=IR$

$$I = \frac{V}{R} = \frac{1}{560} = 1.7857 \text{ mA}$$

$$R = \frac{V}{I} = \frac{1}{1.7857 \times 10^{-3}} = 560 \Omega$$

2. $I = \frac{V}{R} = \frac{2}{560} = 3.5714 \text{ mA}$

$$R = \frac{V}{I} = \frac{2}{3.5714 \times 10^{-3}} = 560 \Omega$$

3. $I = \frac{V}{R} = \frac{3}{560} = 5.3571 \text{ mA}$

$$R = \frac{V}{I} = \frac{3}{5.3571 \times 10^{-3}} = 560 \Omega$$

4. $I = \frac{V}{R} = \frac{4}{560} = 7.1428 \text{ mA}$

$$R = \frac{V}{I} = \frac{4}{7.1428 \times 10^{-3}} = 560 \Omega$$

5. $I = \frac{V}{R} = \frac{5}{560} = 8.9286 \text{ mA}$

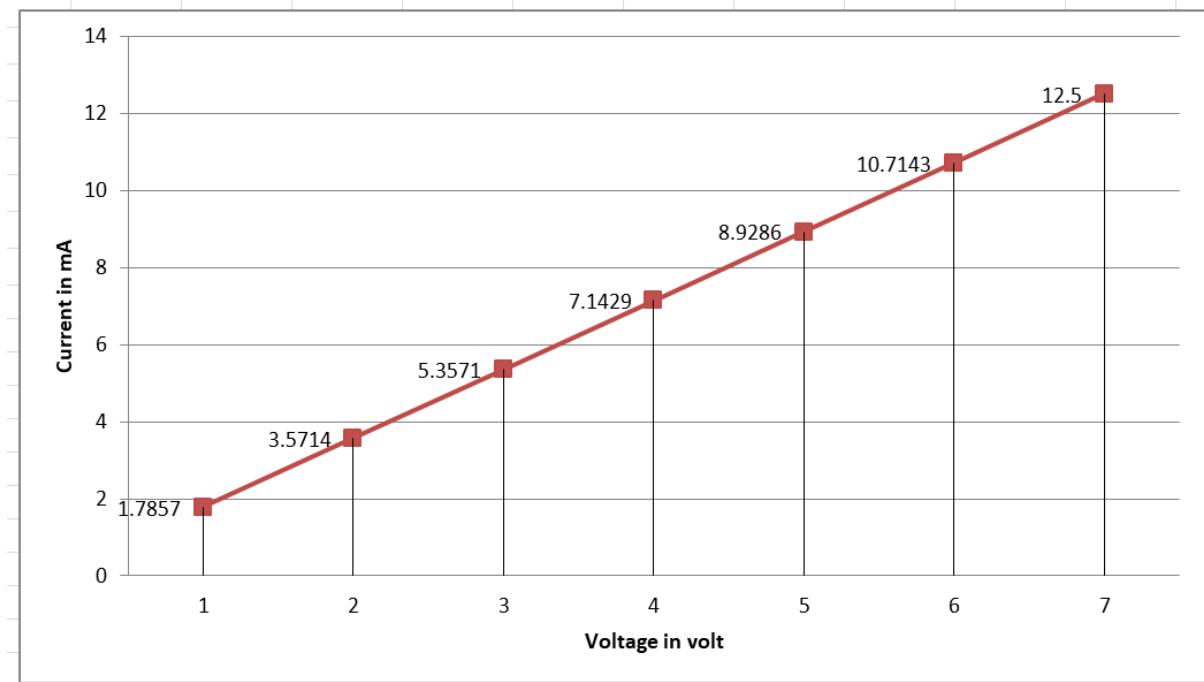
$$R = \frac{V}{I} = \frac{5}{8.9286 \times 10^{-3}} = 560 \Omega$$

6. $I = \frac{V}{R} = \frac{6}{560} = 10.7143 \text{ mA}$

$$R = \frac{V}{I} = \frac{6}{10.7143 \times 10^{-3}} = 560 \Omega$$

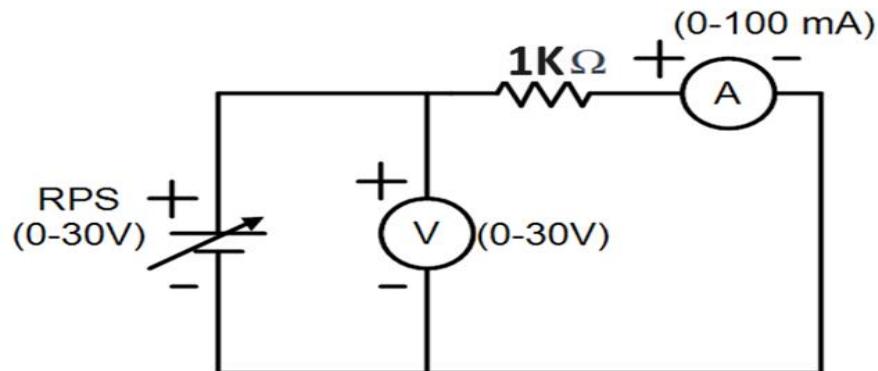
7. $I = \frac{V}{R} = \frac{7}{560} = 12.5 \text{ mA}$

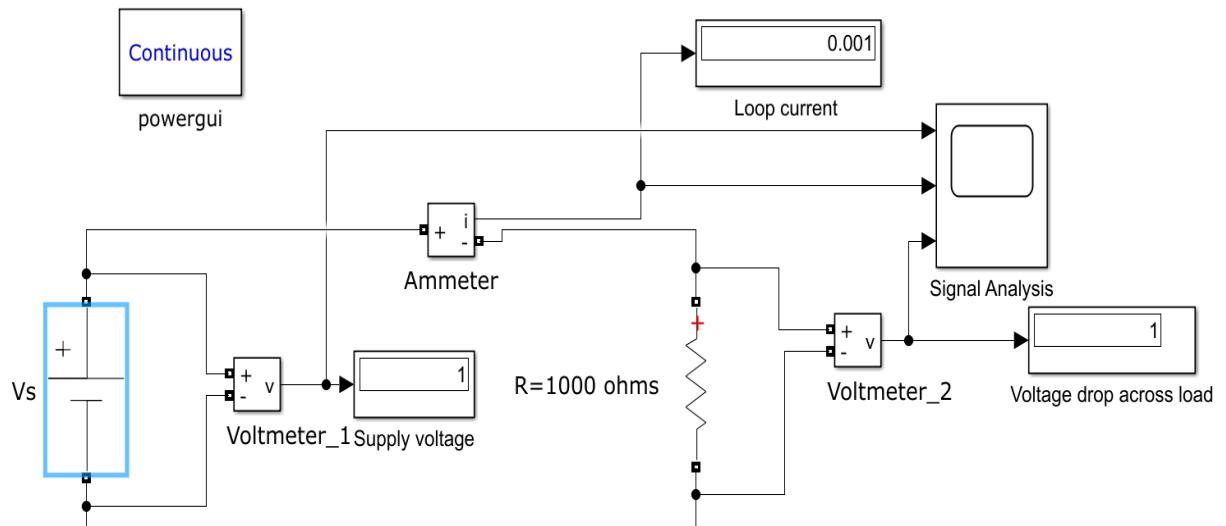
$$R = \frac{V}{I} = \frac{7}{12.5 \times 10^{-3}} = 560 \Omega$$



Test case 3:

Conduct a simulation to verify Ohm's law with a relevant circuit using matlab Simulink.





Tabulations:

S.No.	Voltage (V)	Current (mA)	Simulation Value $R = V/I \text{ in } \Omega$	Theoretical Value $R = V/I \text{ in } \Omega$
1.	1	1	1000	1000
2.	2	2	1000	1000
3.	3	3	1000	1000
4.	4	4	1000	1000
5.	5	5	1000	1000
6.	6	6	1000	1000
7.	7	7	1000	1000

THEORETICAL CALCULATIONS

1. $\mathbf{V} = \mathbf{IR}$

$$I = \frac{V}{R} = \frac{1}{1000} = 1mA$$

$$R = \frac{V}{I} = \frac{1}{1 \times 10^{-3}} = 1000\Omega$$

$$2. I = \frac{V}{R} = \frac{2}{1000} = 2mA$$

$$R = \frac{V}{I} = \frac{2}{2 \times 10^{-3}} = 1000\Omega$$

$$3. I = \frac{V}{R} = \frac{3}{1000} = 3mA$$

$$R = \frac{V}{I} = \frac{3}{3 \times 10^{-3}} = 1000\Omega$$

$$4. I = \frac{V}{R} = \frac{4}{1000} = 4mA$$

$$R = \frac{V}{I} = \frac{4}{4 \times 10^{-3}} = 1000\Omega$$

$$5. I = \frac{V}{R} = \frac{5}{1000} = 5mA$$

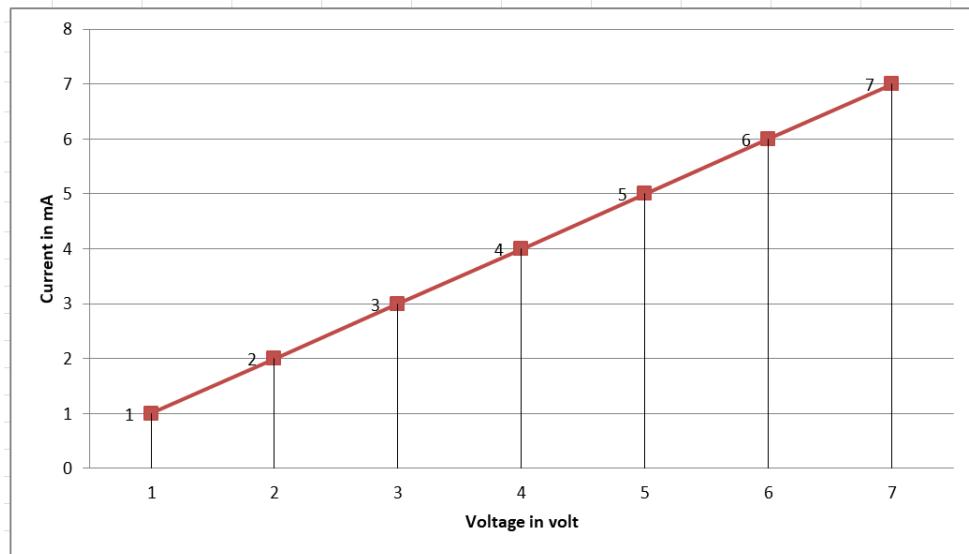
$$R = \frac{V}{I} = \frac{5}{5 \times 10^{-3}} = 1000\Omega$$

$$6. I = \frac{V}{R} = \frac{6}{1000} = 6mA$$

$$R = \frac{V}{I} = \frac{6}{6 \times 10^{-3}} = 1000\Omega$$

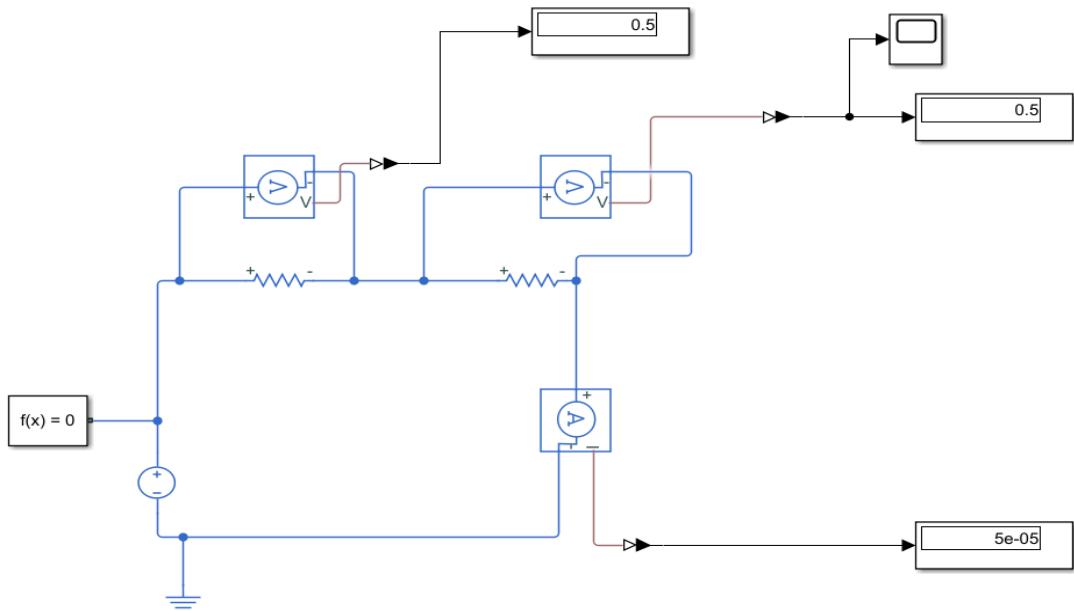
$$7. I = \frac{V}{R} = \frac{7}{1000} = 7mA$$

$$R = \frac{V}{I} = \frac{7}{7 \times 10^{-3}} = 1000\Omega$$



Test case 4:

Conduct a simulation to verify Ohm's law with a relevant circuit using matlab Simscape.



Tabulations:

S.No.	Voltage (V)	Current (mA)	Simulation Value $R = V/I$ in Ω	Theoretical Value $R = V/I$ in Ω
1.	1	0.05	20000	20000
2.	2	0.1	20000	20000
3.	3	0.15	20000	20000

4.	4	0.2	20000	20000
5.	5	0.25	20000	20000
6.	6	0.3	20000	20000
7.	7	0.35	20000	20000

THEORETICAL CALCULATIONS

1. $V=IR$

$$I = \frac{V}{R} = \frac{1}{20000} = 0.05mA$$

$$R = \frac{V}{I} = \frac{1}{0.05 \times 10^{-3}} = 20000\Omega$$

$$2. I = \frac{V}{R} = \frac{2}{20000} = 0.1mA$$

$$R = \frac{V}{I} = \frac{2}{0.1 \times 10^{-3}} = 20000\Omega$$

$$3. I = \frac{V}{R} = \frac{3}{20000} = 0.15mA$$

$$R = \frac{V}{I} = \frac{3}{0.15 \times 10^{-3}} = 20000\Omega$$

$$4. I = \frac{V}{R} = \frac{4}{20000} = 0.2mA$$

$$R = \frac{V}{I} = \frac{4}{0.2 \times 10^{-3}} = 20000\Omega$$

$$5. I = \frac{V}{R} = \frac{5}{20000} = 0.25mA$$

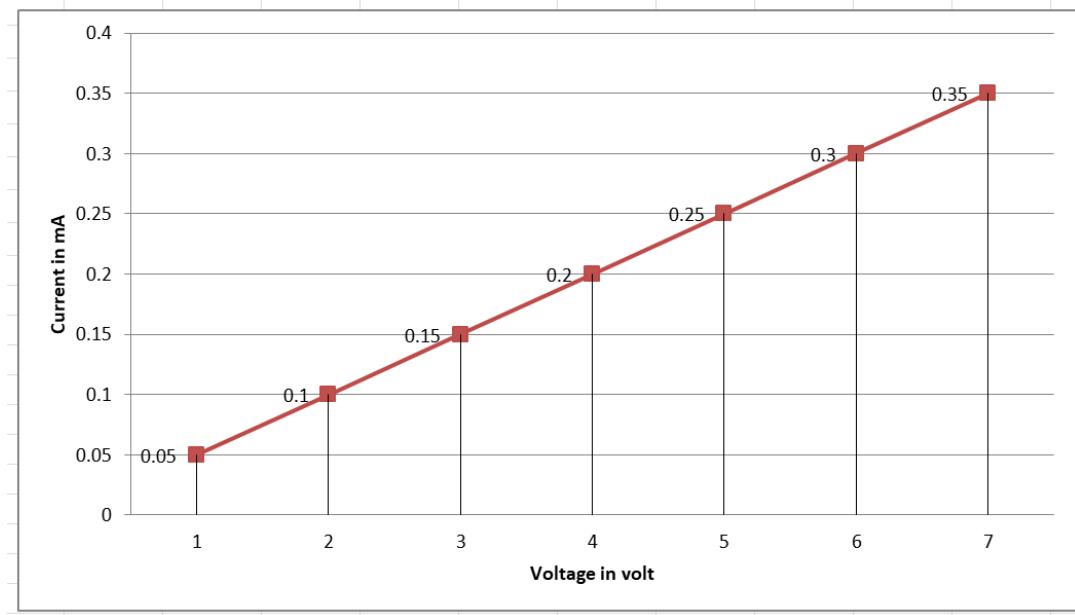
$$R = \frac{V}{I} = \frac{5}{0.25 \times 10^{-3}} = 20000\Omega$$

$$6. I = \frac{V}{R} = \frac{6}{20000} = 0.3mA$$

$$R = \frac{V}{I} = \frac{6}{0.3 \times 10^{-3}} = 20000\Omega$$

$$7. I = \frac{V}{R} = \frac{7}{20000} = 0.35mA$$

$$R = \frac{V}{I} = \frac{7}{0.35 \times 10^{-3}} = 20000\Omega$$



AIM:

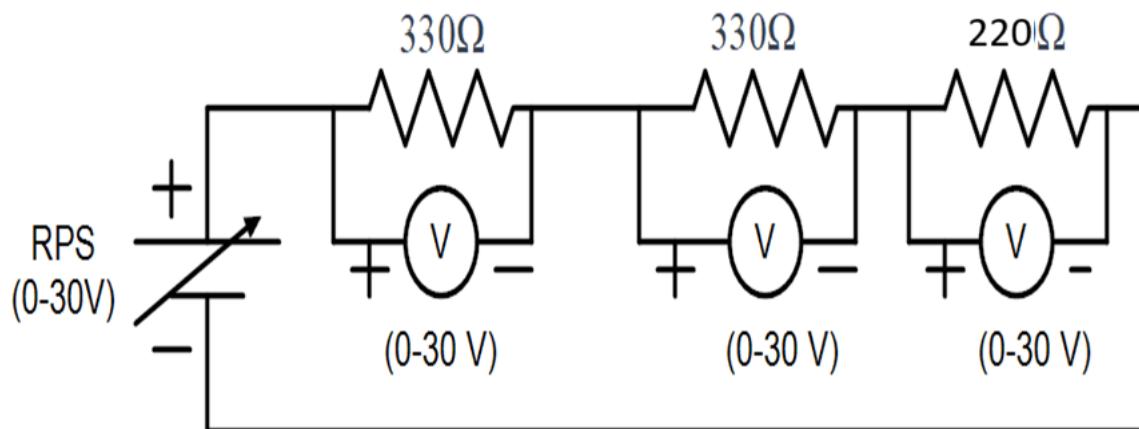
1. To verify Kirchhoff's voltage law.
2. To verify the Kirchhoff's current law.

APPARATUS REQUIRED:

S.No	Name of The Equipment	Type	Range	Qty
1.	RPS	-	(0-15) V	1
2.	Bread board	-	-	1
3.	Ammeter	MC MC	(0-10) mA (0-5) mA	1 2
4.	Voltmeter	MC MC	(0-10)V (0-15) V	1 1
5.	Resistor	-	470Ω , 330Ω, 4kΩ, 4.7kΩ	Each 1
6.	Connecting wires	-	-	As required

THEORY:**KIRCHHOFF'S VOLTAGE LAW (KVL):**

In any network the algebraic sum of the voltage drops across the circuit elements of any closed path is equal to the algebraic sum of the emf's in the path.

CIRCUIT DIAGRAM FOR KVL:

KIRCHHOFF'S CURRENT LAW (KCL):

Kirchhoff's Current law states that the algebraic sum of current entering any node is zero. In other words the sum of current going into a node must be equal to current going out from the node.

PRECAUTIONS:

1. Keep RPS at maximum when switching ON and OFF the power supply.
2. Connections should properly check before switch ON the supply.

PROCEDURE:

1. Connections are given as per the circuit diagram.
2. Apply d.c voltage to the circuit from the given RPS.
3. Tabulate the Voltmeters and Ammeters readings for the corresponding experiment.
4. Increase the voltage step by step to get different readings till the voltage reached up to 15V.
5. Repeat step 3 for different values.
6. Switch OFF the power supply after bringing RPS to the minimum voltage position.

Tabulation for KVL:

Parameter	Experimental Value				Theoretical Value			
	Voltage Across R ₁	Voltage Across R ₂	Voltage Across R ₃	Loop Current(mA)	Voltage Across R ₁	Voltage Across R ₂	Voltage Across R ₃	Loop Current(mA)
20V	7.2	7.3	4.5	21	7.5V	7.5V	5V	22.73

Theoretical Calculation:

$$V = 20V$$

$$R = R_1 + R_2 + R_3$$

$$R = 330 + 330 + 220 = 880\Omega$$

$$I = \frac{V}{R} = \frac{20}{880} = 0.02273A = 22.73mA$$

$$V_1 = IR_1 = 0.02273 \times 330 = 7.5V$$

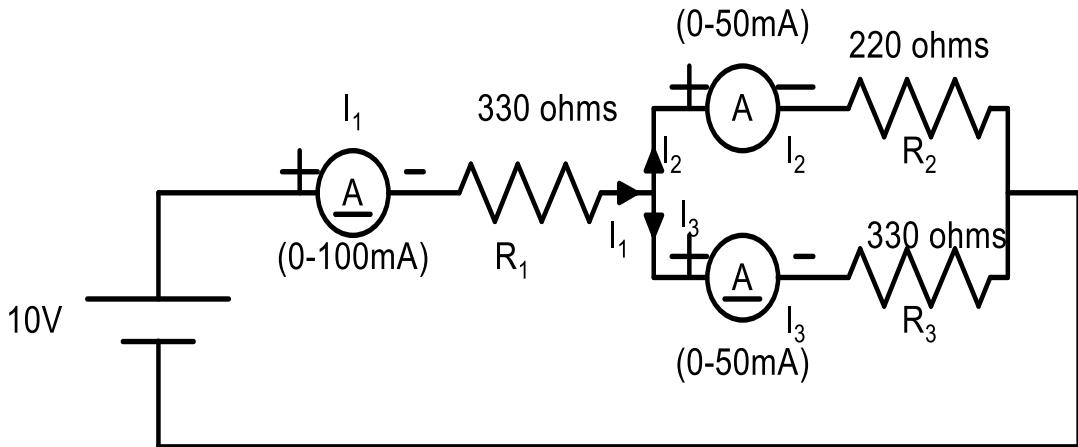
$$V_2 = IR_2 = 0.02273 \times 330 = 7.5V$$

$$V_3 = IR_3 = 0.02273 \times 220 = 5V$$

$$V = V_1 + V_2 + V_3$$

$$V = 7.5 + 7.5 + 5 = 20V$$

1. (b) Verification of Kirchhoff's Current Law



Tabulation for KCL:

Parameter	Experimental Value				Theoretical Value			
Supply voltage	Current I ₁ (mA)	Current I ₂ (mA)	Current I ₃ (mA)	I ₂ + I ₃ (mA)	Current I ₁ (mA)	Current I ₂ (mA)	Current I ₃ (mA)	I ₂ + I ₃
10V	19.5	11.5	8	19.5	21.64	12.98	8.6575	21.64

Theoretical Calculation:

To Find R_{eq}:

$$R_{eq} = R_1 + R_2 \parallel R_3$$

$$R_{eq} = 330 + 220 \parallel 330$$

$$R_{eq} = 330 + \left(\frac{220 \times 330}{220 + 330} \right) = 462\Omega$$

$$V = 10V$$

$$I = \frac{V}{R} = \frac{10}{462} = 0.02164A = 21.64mA$$

$$V_1 = I_1 R_1 = 0.02164 \times 330 = 7.14V$$

$$V = V_1 + V_2$$

$$10 = 7.14 + V_2$$

$$V_2 = 2.857V$$

$$I_2 = \frac{V_2}{R_2} = \frac{2.857}{220} = 0.01298 = 12.98mA$$

$$I_3 = \frac{V_3}{R_3} = \frac{2.857}{330} = 8.6575mA$$

sum of incoming current = sum of outgoing current

$$I_1 = I_2 + I_3$$

$$I_1 = 12.98 + 8.657 = 21.64mA$$

Marks Obtained:

Theoretical Calculations	20	
Observation	20	
Execution of practice examples	30	
Viva	10	
Record	20	
Total Score	100	
Date of experiment		
Date of record submission		Faculty signature

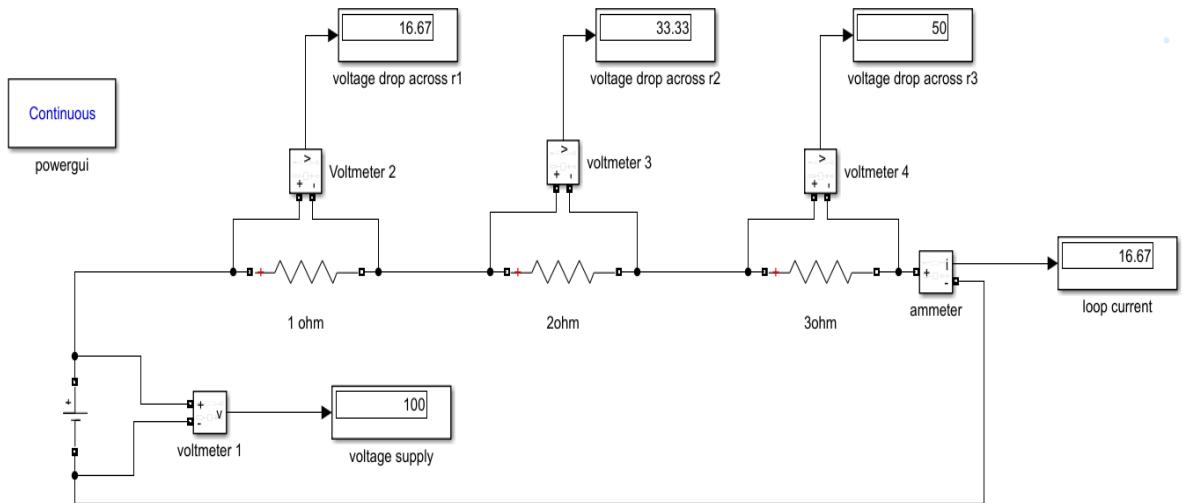
RESULT:

Thus the Kirchhoff's voltage and current law is verified for the given circuit.

Kirchhoffs Voltage law

Test Case 1:

Design a circuit to verify Kirchoff's voltage law for input voltages 100 V which uses three resistors $R_1 = 1 \text{ ohm}$, $R_2 = 2 \text{ ohm}$ and $R_3 = 3 \text{ ohm}$ connected in series and this combination is connected across a constant DC source. Also, verify the results by Matlab simulink



Tabulation:

Parameter	Simulation Value				Theoretical Value			
	Voltage Across R_1	Voltage Across R_2	Voltage Across R_3	Loop Current	Voltage Across R_1	Voltage Across R_2	Voltage Across R_3	Loop Current
Supply voltage	16.67V	33.33V	50 V	16.67A	16.67V	33.33V	50 V	16.67A
100V								

Theoretical Calculation:

Supply voltage $V=100\text{V}$

Total Resistance $R = R_1 + R_2 + R_3 = 1+2+3=6\Omega$

$$\text{Current } I = \frac{V}{R} = \frac{100}{6} = 16.67\text{A}$$

$$V_1 = IR_1 = 16.67 \times 1 = 16.67\text{V}$$

$$V_2 = IR_2 = 16.67 \times 2 = 33.33\text{V}$$

$$V_3 = IR_3 = 16.67 \times 3 = 50\text{V}$$

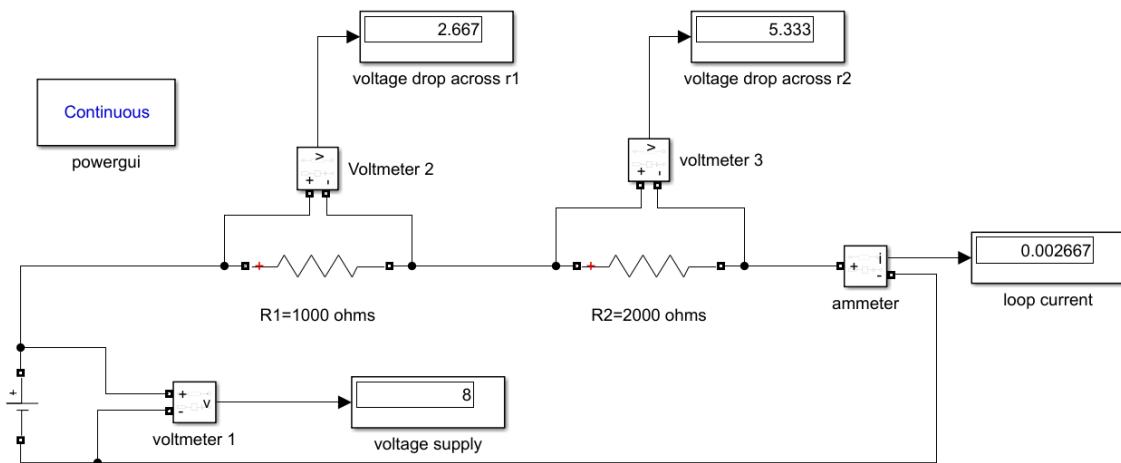
Kirchhoff's Voltage Law (KVL) states:

"The sum of all voltage drops around a closed loop in a circuit is equal to zero."

$$V = V_1 + V_2 + V_3 = 16.67 + 33.33 + 50 = 100V$$

Test Case 2:

Design a circuit to verify Kirchoff's Voltage law for input voltages $V=8V$. The circuit uses $R_1= 1k\Omega$ and $R_2= 2 k\Omega$. This setup is connected across a constant voltage source. Also, verify the results by Matlab simulink



Tabulation:

Parameter	Simulation Value			Theoretical Value		
Supply voltage	Voltage Across R_1	Voltage Across R_2	Loop Current	Voltage Across R_1	Voltage Across R_2	Loop Current
8V	2.667V	5.333V	2.667mA	2.667V	5.333V	2.667mA

Theoretical Calculation:

Supply voltage $V=100V$

Total Resistance $R = R_1 + R_2 = 1000 + 2000 = 3000\Omega$

$$\text{Current } I = \frac{V}{R} = \frac{8}{3000} = 2.667\text{mA}$$

$$V_1 = IR_1 = 2.667 \times 10^{-3} \times 1000 = 2.667V$$

$$V_2 = IR_2 = 2.667 \times 10^{-3} \times 2000 = 5.333V$$

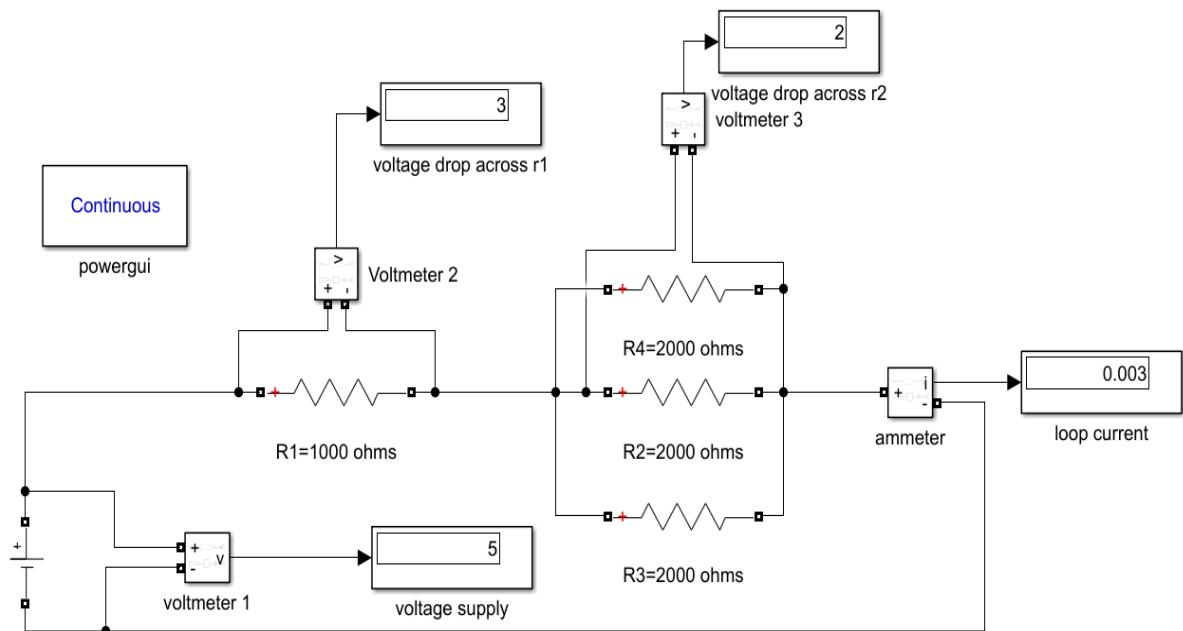
Kirchhoff's Voltage Law (KVL) states:

"The sum of all voltage drops around a closed loop in a circuit is equal to zero."

$$V = V_1 + V_2 = 2.667 + 5.333 = 8V$$

Test Case 3:

Design a circuit to verify Kirchoff's Voltage law for input voltages $V=5V$. The circuit uses $R_1 = 1k\Omega$ connected in series and three resistor R_2, R_3 and R_4 are $2 k\Omega$ connected in parallel. This setup is connected across a constant voltage source. Also, verify the results by Matlab simulink



Tabulation:

Parameter	Simulation Value			Theoretical Value		
Supply voltage	Voltage Across R_1	Voltage Across R_2	Loop Current	Voltage Across R_1	Voltage Across R_2	Loop Current
5V	3V	2V	3mA	3V	2V	3mA

Theoretical Calculation:

Supply voltage $V=5V$

$$\text{Total Resistance } R = R_1 + R_2 \parallel R_3 \parallel R_4 = 1000 + 666.667 = 1666.667 \Omega$$

$$\text{Current } I = \frac{V}{R} = \frac{5}{1666.667} = 3 \text{ mA}$$

$$V_1 = IR_1 = 3 \times 10^{-3} \times 1000 = 3V$$

$$V = V_1 + V_2$$

$$5 = 3 + V_2$$

$$V_2 = 2V$$

$$V_2 = I_2 R_2$$

$$I_2 = \frac{V_2}{R_2} = \frac{2}{2000} = 1 \text{ mA}$$

$$I_3 = \frac{V_3}{R_3} = \frac{2}{2000} = 1 \text{ mA}$$

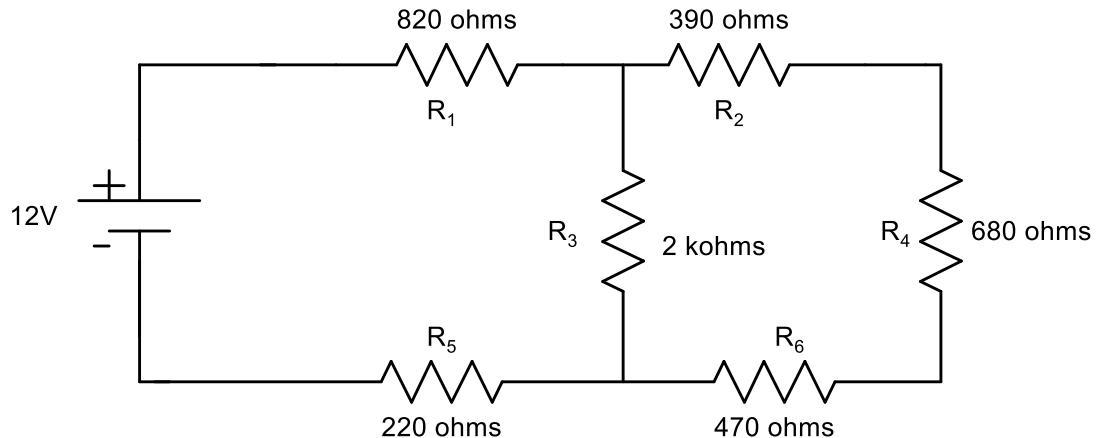
Kirchhoff's Voltage Law (KVL) states:

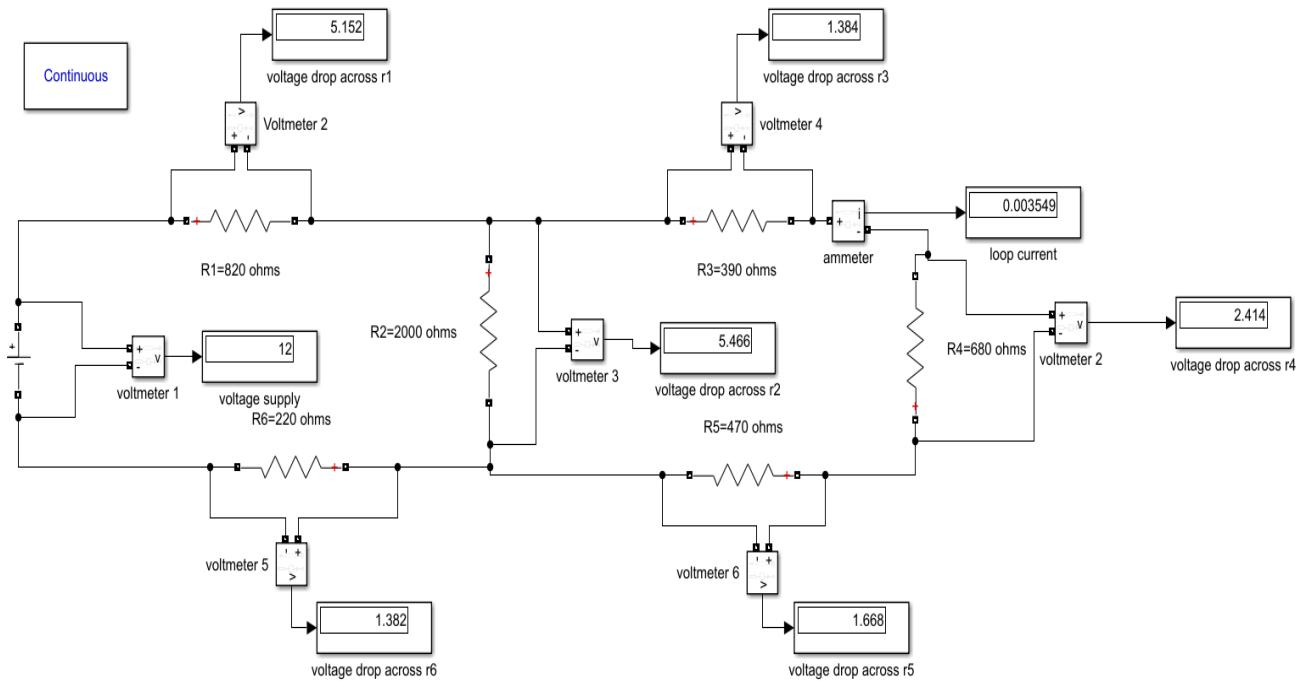
"The sum of all voltage drops around a closed loop in a circuit is equal to zero."

$$V = V_1 + V_2 = 3 + 2 = 5V$$

Test Case 4:

In any closed path / mesh, the algebraic sum of EMF and voltage drops is zero. Prove this Kirchoff's Voltage Law simulated for the below circuit.





Tabulation:

Parameter	Simulation Value					Theoretical Value				
	Voltage Across R ₁	Voltage Across R ₃	Voltage Across R ₄	Voltage Across R ₅	Voltage Across R ₆	Voltage Across R ₁	Voltage Across R ₃	Voltage Across R ₄	Voltage Across R ₅	Voltage Across R ₆
12V	5.152 V	1.384V	2.414V	1.668V	1.382V	5.152 V	1.384V	2.414V	1.668V	1.382V

Theoretical Calculation:

$$V = IR$$

$$\begin{bmatrix} 3040 & -2000 \\ -2000 & 3540 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \end{bmatrix}$$

$$\Delta = 6761600$$

$$\Delta_1 = \begin{bmatrix} 12 & -2000 \\ 0 & 3540 \end{bmatrix}$$

$$\Delta_1 = 42480$$

$$\Delta_2 = \begin{bmatrix} 3040 & 12 \\ -2000 & 0 \end{bmatrix}$$

$$\Delta_2 = 24000$$

$$i_1 = \frac{\Delta_1}{\Delta} = \frac{42480}{6761600} = 6.2825 \text{ mA}$$

$$i_2 = \frac{\Delta_2}{\Delta} = \frac{24000}{6761600} = 3.5494 \text{ mA}$$

$$V_1 = I_1 R_1 = 6.2825 \times 10^{-3} \times 820 = 5.1516V$$

$$V_2 = (I_1 - I_2) R_2 = 2.7331 \times 10^{-3} \times 2000 = 5.466V$$

$$V_3 = I_2 R_3 = 3.5494 \times 10^{-3} \times 390 = 1.3843V$$

$$V_4 = I_2 R_4 = 3.5494 \times 10^{-3} \times 680 = 2.4135V$$

$$V_5 = I_2 R_5 = 3.5494 \times 10^{-3} \times 470 = 1.6682V$$

$$V_6 = I_1 R_6 = 6.2825 \times 10^{-3} \times 220 = 1.3822V$$

Kirchhoff's Voltage Law (KVL) states:

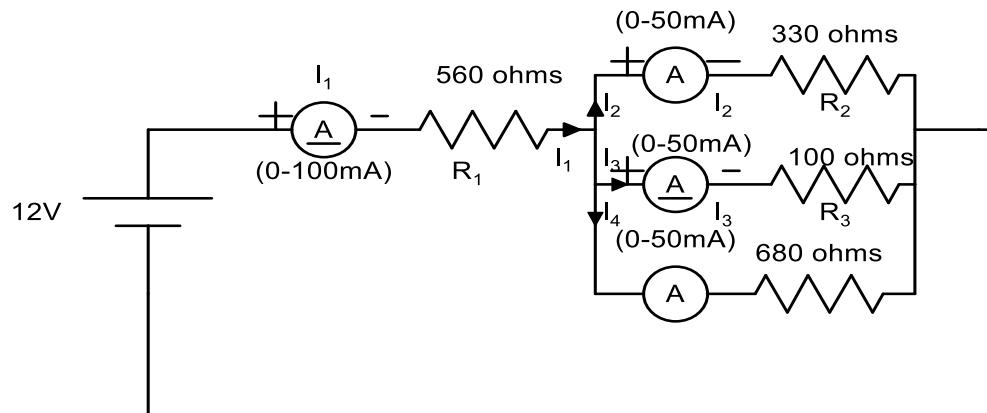
"The sum of all voltage drops around a closed loop in a circuit is equal to zero."

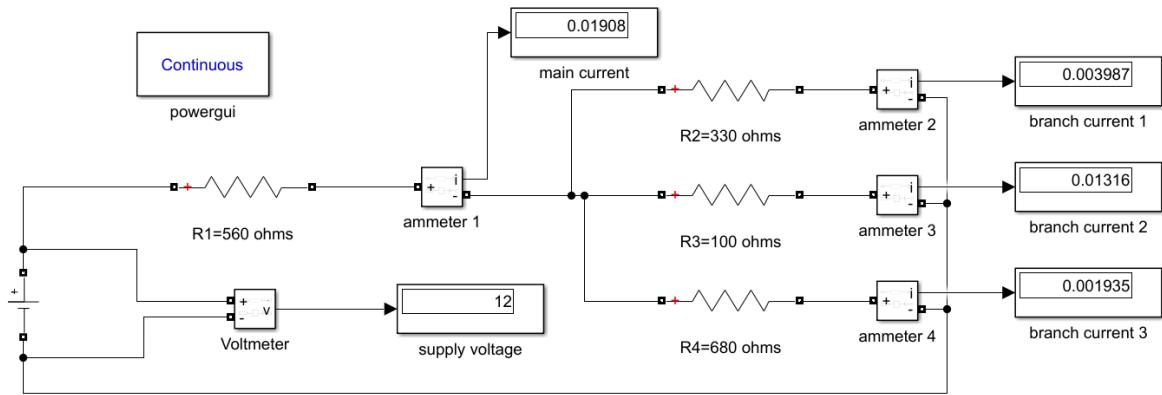
$$V = V_1 + V_3 + V_4 + V_5 + V_6 = 5.152 + 1.3843 + 2.4135 + 1.6682 + 1.3822 = 12V$$

Kirchhoffs Current law

Test Case 1:

Solve the currents in the circuit shown in Fig. 1. And verify the result using matlab Simulink.





Tabulation for KCL:

Parameter	Simulation Value				Theoretical Value			
Supply voltage	Current I ₁ (mA)	Current I ₂ (mA)	Current I ₃ (mA)	Current I ₄ (mA)	Current I ₁ (mA)	Current I ₂ (mA)	Current I ₃ (mA)	Current I ₄ (mA)
12V	19.08	3.987	13.16	1.935	19.08	3.987	13.16	1.935

Theoretical Calculation:

To find equivalent resistance:

$$R_{eq} = R_1 + R_2 \parallel R_3 \parallel R_4$$

$$R_{eq} = 560 + 330 \parallel 100 \parallel 680$$

$$R_{eq} = 560 + \frac{330 \times 100}{330 + 100} \parallel 680$$

$$R_{eq} = 560 + 76.7442 \parallel 680$$

$$R_{eq} = 560 + \frac{76.7442 \times 680}{76.7442 + 680}$$

$$R_{eq} = 628.96\Omega$$

$$V = I_1 R$$

$$I_1 = \frac{V}{R} = \frac{12}{628.9613} = 19.0791mA$$

$$V_1 = I_1 R_1 = 0.019079 \times 560 = 10.68V$$

$$V = V_1 + V_2$$

$$12 = 10.68 + V_2$$

$$V_2 = 1.3157V$$

$$V_2 = I_2 R_2$$

$$1.3157 = I_2 \times 330$$

$$I_2 = 3.9870mA$$

$$V_3 = I_3 R_3$$

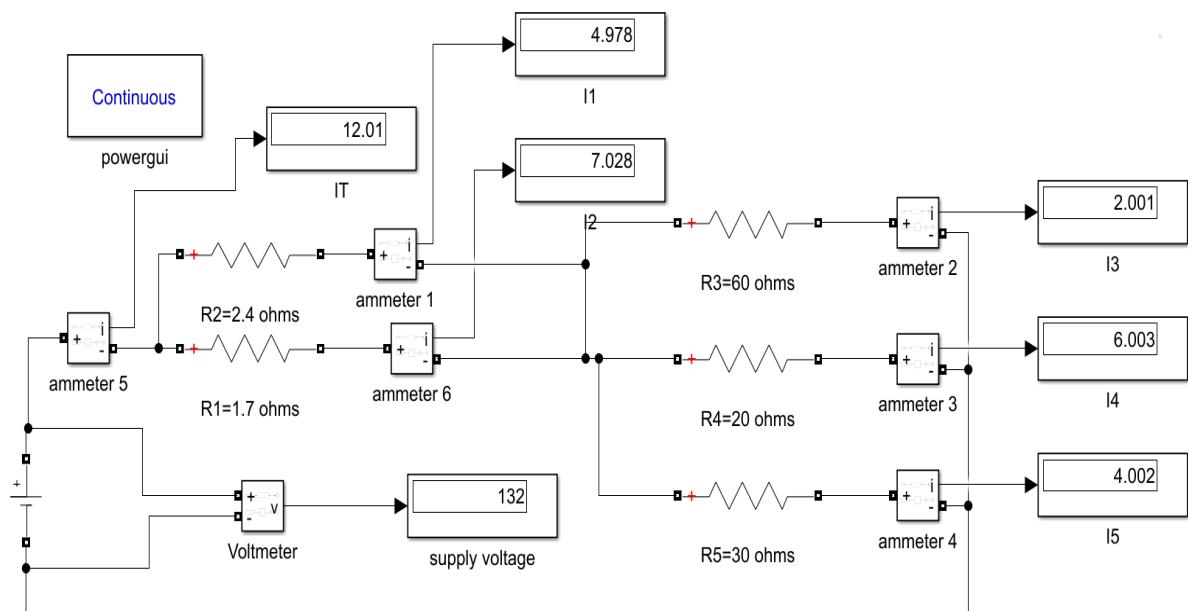
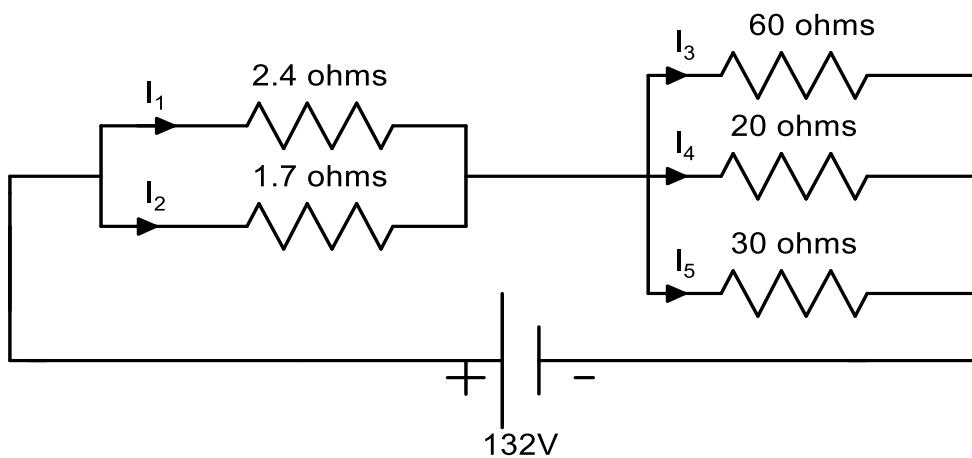
$$I_3 = \frac{V_3}{R_3} = \frac{1.3157}{100} = 13.157mA$$

$$V_4 = I_4 R_4$$

$$I_4 = \frac{V_4}{R_4} = \frac{1.3157}{680} = 1.9348mA$$

Test Case 2:

Solve the currents in the circuit shown in Fig. And verify the result using matlab Simulink.



Tabulation for KCL:

Parameter	Simulation Value							Theoretical Value						
Supply voltage	Current I_T (A)	Current I_1 (A)	Current I_2 (A)	Current I_3 (A)	Current I_4 (A)	Current I_5 (A)	Current I_1 (A)	Current I_2 (A)	Current I_3 (A)	Current I_4 (A)	Current I_5 (A)	Current I_1 (A)		
132V	12.01	4.978	7.028	2	6	4	12.01	4.978	7.028	2	6	4		

Theoretical Calculation:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2.4} + \frac{1}{1.7}$$

$$R_T = 0.995\Omega = 1\Omega$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{60} + \frac{1}{20} + \frac{1}{30}$$

$$R_T = 10\Omega$$

$$R_{eq} = 1 + 10 = 11\Omega$$

$$I_T = \frac{132}{11} = 12A$$

$$V_1 = I_T \times R_1 = 12 \times 1 = 12V$$

$$V = V_1 + V_2$$

$$V_2 = V - V_1 = 132 - 12 = 120V$$

$$I_1 = \frac{V_1}{R_1} = \frac{12}{2.4} = 5A$$

$$I_2 = \frac{V_1}{R_2} = \frac{12}{1.7} = 7A$$

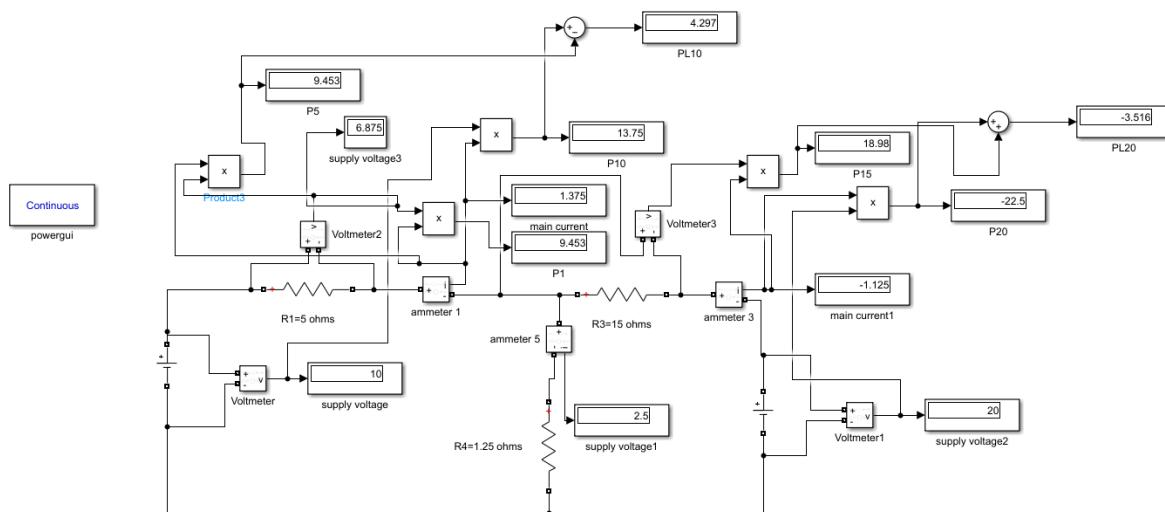
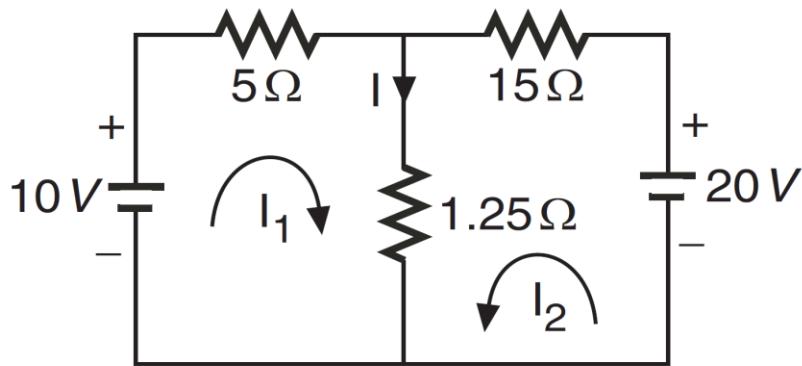
$$I_3 = \frac{V_2}{R_3} = \frac{120}{60} = 2A$$

$$I_4 = \frac{V_2}{R_4} = \frac{120}{20} = 6A$$

$$I_5 = \frac{V_2}{R_5} = \frac{120}{30} = 4A$$

Test Case 3:

In the circuit shown in Fig., find the current I by mesh method and the power supplied by each battery to the 1.25Ω resistor. Verify the result using matlab Simulink.



Tabulation for KCL:

Parameter		Simulation Value					Theoretical Value				
Supply voltage		Current I _T (A)	Current I ₁ (A)	Current I ₂ (A)	Power P ₁₀	Power P ₂₀	Current I ₁ (A)	Current I ₂ (A)	Current I ₃ (A)	Power P ₁₀	Power P ₂₀
V ₁	V ₂	2.5	1.375	1.125	13.75	22.5	2.5	1.375	1.125	13.75	22.5

Theoretical Calculation:

Let us assume two mesh currents as shown in Fig. 2. Now the current I is given by the sum of I_1 and I_2 .

Using the circuit shown in Fig. 1, the mesh basis matrix equation is formed as shown below:

$$\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} E_{11} \\ E_{22} \end{bmatrix}$$

The elements of resistance matrix and source voltage matrix are formed as shown below:

$$\begin{array}{l|l|l} R_{11} = 5 + 1.25 = 6.25 & R_{12} = R_{21} = 1.25 & E_{11} = 10 \\ R_{22} = 15 + 1.25 = 16.25 & & E_{22} = 20 \end{array}$$

On substituting the above terms in equation (1), we get,

$$\begin{bmatrix} 6.25 & 1.25 \\ 1.25 & 16.25 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 20 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 6.25 & 1.25 \\ 1.25 & 16.25 \end{vmatrix} = 6.25 \times 16.25 - 1.25 \times 1.25 = 100$$

$$\Delta_1 = \begin{vmatrix} 10 & 1.25 \\ 20 & 16.25 \end{vmatrix} = 10 \times 16.25 - 20 \times 1.25 = 137.5$$

$$\Delta_2 = \begin{vmatrix} 6.25 & 10 \\ 1.25 & 20 \end{vmatrix} = 6.25 \times 20 - 1.25 \times 10 = 112.5$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{137.5}{100} = 1.375 A$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{112.5}{100} = 1.125 A$$

$$\therefore I = I_1 + I_2 = 1.375 + 1.125 = 2.5 A$$

Let P_{10} and P_{20} be the power delivered by 10 V and 20 V sources.

$$P_{10} = 10 \times I_1 = 10 \times 1.375 = 13.75 W$$

$$P_{20} = 20 \times I_2 = 20 \times 1.125 = 22.5 W$$

Let P_5 and P_{15} be the power consumed by 5 Ω and 15 Ω resistances, respectively.

$$P_5 = I_1^2 \times 5 = 1.375^2 \times 5 = 9.4531 W$$

$$P_{15} = I_2^2 \times 15 = 1.125^2 \times 15 = 18.9844 W$$

Let P_{L10} and P_{L20} be the power delivered to load (i.e., to 1.25 Ω resistor) by the 10 V and 20 V sources, respectively.

$$P_{L10} = P_{10} - P_5 = 13.75 - 9.4531 = 4.2969 W$$

$$P_{L20} = P_{20} - P_{15} = 22.5 - 18.9844 = 3.5156 W$$

Test Case 4:

Solve the mesh currents in the circuit shown in Fig. 1. And verify the result using matlab Simulink.

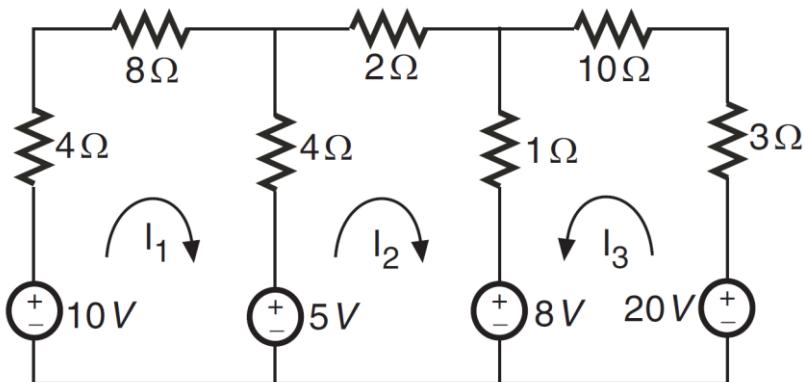
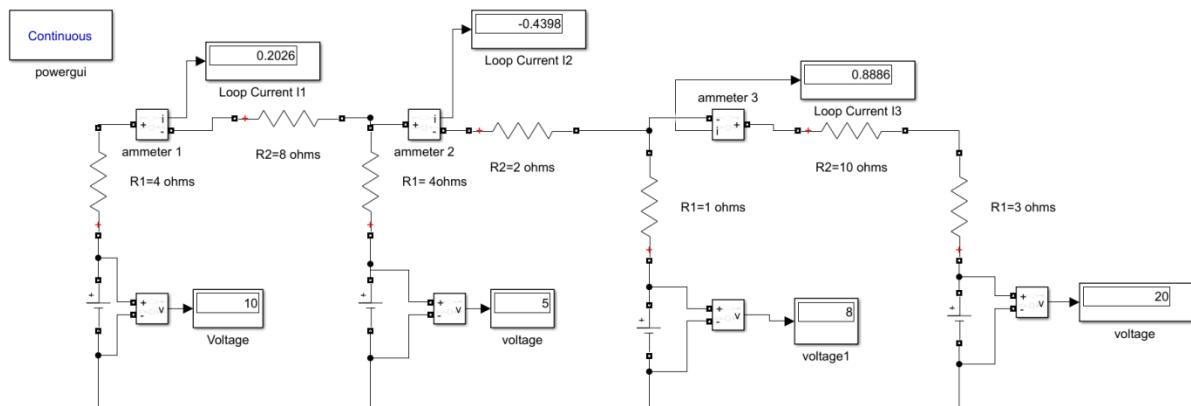


Fig. 1.



Tabulation for KCL:

Parameter	Simulation Value			Theoretical Value		
Supply voltage	Current I_1 (A)	Current I_2 (A)	Current I_3 (A)	Current I_1 (A)	Current I_2 (A)	Current I_3 (A)
10,5,8,20	0.2026	-0.439	0.8886	0.2026	-0.439	0.8886

Theoretical Calculation:

With reference to Fig.1, the mesh basis matrix equation is formed as shown below:

$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} E_{11} \\ E_{22} \\ E_{33} \end{bmatrix}$$

The elements of the resistance matrix and source voltage matrix are formed as shown below:

$$\begin{array}{l|l|l} R_{11} = 4 + 8 + 4 = 16 & R_{12} = R_{21} = -4 & E_{11} = 10 - 5 = 5 \\ R_{22} = 4 + 2 + 1 = 7 & R_{13} = R_{31} = 0 & E_{22} = 5 - 8 = -3 \\ R_{33} = 1 + 10 + 3 = 14 & R_{23} = R_{32} = 1 & E_{33} = 20 - 8 = 12 \end{array}$$

On substituting the above terms in equation (1), we get,

$$\begin{bmatrix} 16 & -4 & 0 \\ -4 & 7 & 1 \\ 0 & 1 & 14 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 5 \\ -3 \\ 12 \end{bmatrix}$$

In equation (2), the unknowns are I_1 , I_2 and I_3 . In order to solve I_1 , I_2 and I_3 , let us define four determinants Δ , Δ_1 , Δ_2 and Δ_3 as shown below:

$$\Delta = \begin{vmatrix} 16 & -4 & 0 \\ -4 & 7 & 1 \\ 0 & 1 & 14 \end{vmatrix}; \quad \Delta_1 = \begin{vmatrix} 5 & -4 & 0 \\ -3 & 7 & 1 \\ 12 & 1 & 14 \end{vmatrix}; \quad \Delta_2 = \begin{vmatrix} 16 & 5 & 0 \\ -4 & -3 & 1 \\ 0 & 12 & 14 \end{vmatrix}; \quad \Delta_3 = \begin{vmatrix} 16 & -4 & 5 \\ -4 & 7 & -3 \\ 0 & 1 & 12 \end{vmatrix}$$

The determinants are evaluated by expanding along first row and the mesh currents are solved by Cramer's rule.

$$\begin{aligned} \Delta &= \begin{vmatrix} 16 & -4 & 0 \\ -4 & 7 & 1 \\ 0 & 1 & 14 \end{vmatrix} = 16 \times [7 \times 14 - 1 \times 1] - (-4) \times [-4 \times 14 - 0] + 0 \\ &= 1552 - 224 = 1328 \end{aligned}$$

$$\begin{aligned} \Delta_1 &= \begin{vmatrix} 5 & -4 & 0 \\ -3 & 7 & 1 \\ 12 & 1 & 14 \end{vmatrix} = 5 \times [7 \times 14 - 1 \times 1] - (-4) \times [-3 \times 14 - 12 \times 1] + 0 \\ &= 485 - 216 = 269 \end{aligned}$$

$$\begin{aligned} \Delta_2 &= \begin{vmatrix} 16 & 5 & 0 \\ -4 & -3 & 1 \\ 0 & 12 & 14 \end{vmatrix} = 16 \times [-3 \times 14 - 12 \times 1] - 5 \times [-4 \times 14 - 0] + 0 \\ &= -864 + 280 = -584 \end{aligned}$$

$$\begin{aligned} \Delta_3 &= \begin{vmatrix} 16 & -4 & 5 \\ -4 & 7 & -3 \\ 0 & 1 & 12 \end{vmatrix} = 16 \times [7 \times 12 - 1 \times (-3)] - (-4) \times [-4 \times 12 - 0] + 5 \times [-4 \times 1 - 0] \\ &= 1392 - 192 - 20 = 1180 \end{aligned}$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{269}{1328} = 0.2026 \text{ A}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-584}{1328} = -0.4398 \text{ A}$$

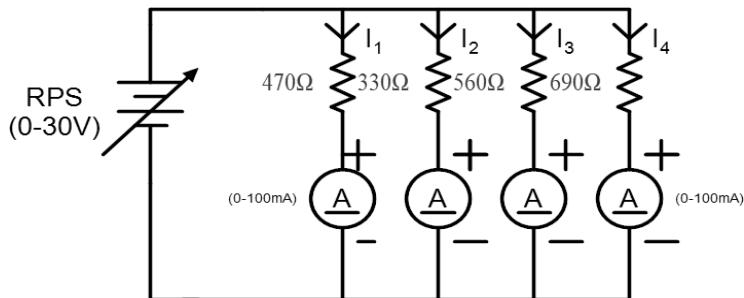
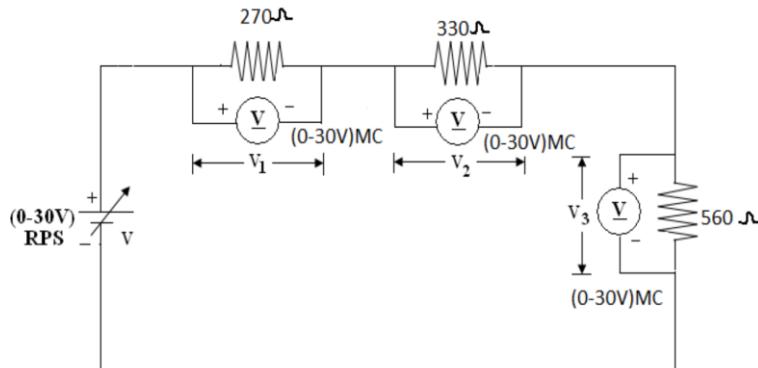
$$I_3 = \frac{\Delta_3}{\Delta} = \frac{1180}{1328} = 0.8886 \text{ A}$$

Expt. No. 02**Verification of current and voltage division rules****AIM:**

To calculate the individual branch currents and total current drawn from the power supply using current and voltage division rules.

APPARATUS REQUIRED:

S.No.	Apparatus Name	Range	Quantity
1	DC Regulated Power Supply	(0-30)V	1
2	Ammeter	(0-200)mA	4
3	Resistor	1k Ω , 220 Ω	Each two
4	Bread board & Connecting wires	--	Required

CIRCUIT DIAGRAM:**CURRENT DIVISION CIRCUIT DIAGRAM:****Voltage Division Circuit Diagram:****PROCEDURE:**

1. Give the connections as per the circuit diagram.
2. Set a particular value in RPS.
3. Note down the corresponding ammeter reading
4. Repeat the same for different voltages

OBSERVATIONS:

CURRENT DIVISION RULE:

S. No.	Voltage (V)	Current (mA)			
		I ₁	I ₂	I ₃	I ₄
1	1	5	10.64	15.15	8.93
2	2	10	21.28	30.3	17.86
3	3	15	31.91	45.45	26.79
4	4	20	42.55	60.61	35.71
5	5	25	53.19	75.76	44.64

VOLTAGE DIVISION RULE:

S. No.	RPS Voltage (V)	Voltage across Resistors (V)			V ₁ +V ₂ +V ₃ (V)
		V ₁	V ₂	V ₃	
1	5	1.16	1.42	2.41	5
2	10	2.32	2.84	4.83	10
3	15	3.49	4.26	7.24	15
4	20	4.65	5.68	9.66	20
5	25	5.81	7.1	12.07	25

MODEL CALCULATIONS:

CURRENT DIVISION RULE:

For Voltage (V) = 5V:

Resistor R₁ = 470 Ω:

$$I_1 = V / R_1 = 5V / 470\Omega = 10.64 \text{ mA}$$

Resistor R₂ = 330 Ω:

$$I_2 = V / R_2 = 5V / 330\Omega = 15.15 \text{ mA}$$

Resistor R₃ = 560 Ω:

$$I_3 = V / R_3 = 5V / 560\Omega = 8.93 \text{ mA}$$

Resistor R₄ = 690 Ω:

$$I_4 = V / R_4 = 5V / 690\Omega = 7.25 \text{ mA}$$

For Voltage (V) = 10V:

Resistor R₁ = 470 Ω:

$$I_1 = V / R_1 = 10V / 470\Omega = 21.28 \text{ mA}$$

Resistor R₂ = 330 Ω:

$$I_2 = V / R_2 = 10V / 330\Omega = 30.30 \text{ mA}$$

Resistor R₃ = 560 Ω:

$$I_3 = V / R_3 = 10V / 560\Omega = 17.86 \text{ mA}$$

Resistor R4 = 690 Ω:
 $I_4 = V / R_4 = 10V / 690\Omega = 14.49 \text{ mA}$

For Voltage (V) = 15V:

Resistor R1 = 470 Ω:
 $I_1 = V / R_1 = 15V / 470\Omega = 31.91 \text{ mA}$
Resistor R2 = 330 Ω:
 $I_2 = V / R_2 = 15V / 330\Omega = 45.45 \text{ mA}$
Resistor R3 = 560 Ω:
 $I_3 = V / R_3 = 15V / 560\Omega = 26.79 \text{ mA}$
Resistor R4 = 690 Ω:
 $I_4 = V / R_4 = 15V / 690\Omega = 21.74 \text{ mA}$

For Voltage (V) = 20V:

Resistor R1 = 470 Ω:
 $I_1 = V / R_1 = 20V / 470\Omega = 42.55 \text{ mA}$
Resistor R2 = 330 Ω:
 $I_2 = V / R_2 = 20V / 330\Omega = 60.61 \text{ mA}$
Resistor R3 = 560 Ω:
 $I_3 = V / R_3 = 20V / 560\Omega = 35.71 \text{ mA}$
Resistor R4 = 690 Ω:
 $I_4 = V / R_4 = 20V / 690\Omega = 28.99 \text{ mA}$

For Voltage (V) = 25V:

Resistor R1 = 470 Ω:
 $I_1 = V / R_1 = 25V / 470\Omega = 53.19 \text{ mA}$
Resistor R2 = 330 Ω:
 $I_2 = V / R_2 = 25V / 330\Omega = 75.76 \text{ mA}$
Resistor R3 = 560 Ω:
 $I_3 = V / R_3 = 25V / 560\Omega = 44.64 \text{ mA}$
Resistor R4 = 690 Ω:
 $I_4 = V / R_4 = 25V / 690\Omega = 36.23 \text{ mA}$

VOLTAGE DIVISION RULE:

For RPS Voltage (V) = 5V:

Voltage across Resistor R1 (270 Ω):
 $V_1 = 5 * (270 / 1160) = 1.16 \text{ V}$
Voltage across Resistor R2 (330 Ω):
 $V_2 = 5 * (330 / 1160) = 1.42 \text{ V}$
Voltage across Resistor R3 (560 Ω):
 $V_3 = 5 * (560 / 1160) = 2.41 \text{ V}$

Check: $V_1 + V_2 + V_3 = 1.16 + 1.42 + 2.41 = 5.00 \text{ V}$

For RPS Voltage (V) = 10V:

Voltage across Resistor R1 (270 Ω):

$$V1 = 10 * (270 / 1160) = 2.33 \text{ V}$$

Voltage across Resistor R2 (330Ω):

$$V2 = 10 * (330 / 1160) = 2.84 \text{ V}$$

Voltage across Resistor R3 (560Ω):

$$V3 = 10 * (560 / 1160) = 4.83 \text{ V}$$

Check: $V1 + V2 + V3 = 2.33 + 2.84 + 4.83 = 10.00 \text{ V}$

For RPS Voltage (V) = 15V:

Voltage across Resistor R1 (270Ω):

$$V1 = 15 * (270 / 1160) = 3.49 \text{ V}$$

Voltage across Resistor R2 (330Ω):

$$V2 = 15 * (330 / 1160) = 4.27 \text{ V}$$

Voltage across Resistor R3 (560Ω):

$$V3 = 15 * (560 / 1160) = 7.24 \text{ V}$$

Check: $V1 + V2 + V3 = 3.49 + 4.27 + 7.24 = 15.00 \text{ V}$

For RPS Voltage (V) = 20V:

Voltage across Resistor R1 (270Ω):

$$V1 = 20 * (270 / 1160) = 4.66 \text{ V}$$

Voltage across Resistor R2 (330Ω):

$$V2 = 20 * (330 / 1160) = 5.69 \text{ V}$$

Voltage across Resistor R3 (560Ω):

$$V3 = 20 * (560 / 1160) = 9.66 \text{ V}$$

Check: $V1 + V2 + V3 = 4.66 + 5.69 + 9.66 = 20.00 \text{ V}$

For RPS Voltage (V) = 25V:

Voltage across Resistor R1 (270Ω):

$$V1 = 25 * (270 / 1160) = 5.82 \text{ V}$$

Voltage across Resistor R2 (330Ω):

$$V2 = 25 * (330 / 1160) = 7.11 \text{ V}$$

Voltage across Resistor R3 (560Ω):

$$V3 = 25 * (560 / 1160) = 12.07 \text{ V}$$

Check: $V1 + V2 + V3 = 5.82 + 7.11 + 12.07 = 25.00 \text{ V}$

RESULT:

Thus, the individual branch currents and total current drawn from the power supply are calculated using current and voltage division rules.

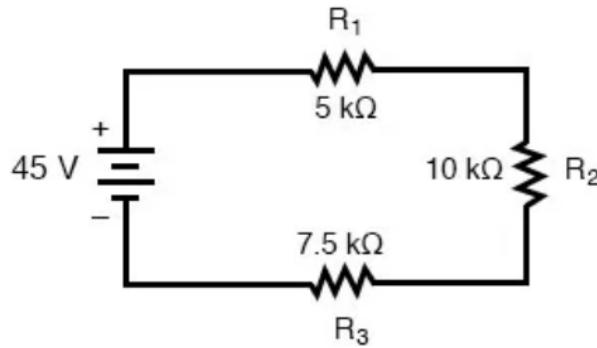
EXP 02: VOLTAGE DIVISION AND CURRENT DIVISION

Case 01:

Analyze the given circuit where a resistor $R_1=5\text{ k}\Omega$, $R_2=10\text{ k}\Omega$, and $R_3=7.5\text{ k}\Omega$ are connected in a series circuit powered by a 45V DC source.

Instructions:

- Simulate the circuit on MATLAB/Simulink or NI Multisim to verify your calculated values.
- Report the simulated current and voltage drops across each resistor and compare them with your calculated values.



Step 1: Calculate the Total Resistance

Since all the resistors are in series, the total resistance R_{total} is the sum of all the resistances:

$$R_{total} = R_1 + R_2 + R_3 = 5\text{ k}\Omega + 10\text{ k}\Omega + 7.5\text{ k}\Omega = 22.5\text{ k}\Omega$$

Step 2: Calculate the Total Current using Ohm's Law

$$I_{total} = \frac{V_{total}}{R_{total}} = \frac{45V}{22.5\text{ k}\Omega} = 2\text{ mA}$$

Step 3: Apply Voltage Division Rule

- Voltage across R_1 :

$$V_{R_1} = I_{total} \times R_1 = 2\text{ mA} \times 5\text{ k}\Omega = 10\text{ V}$$

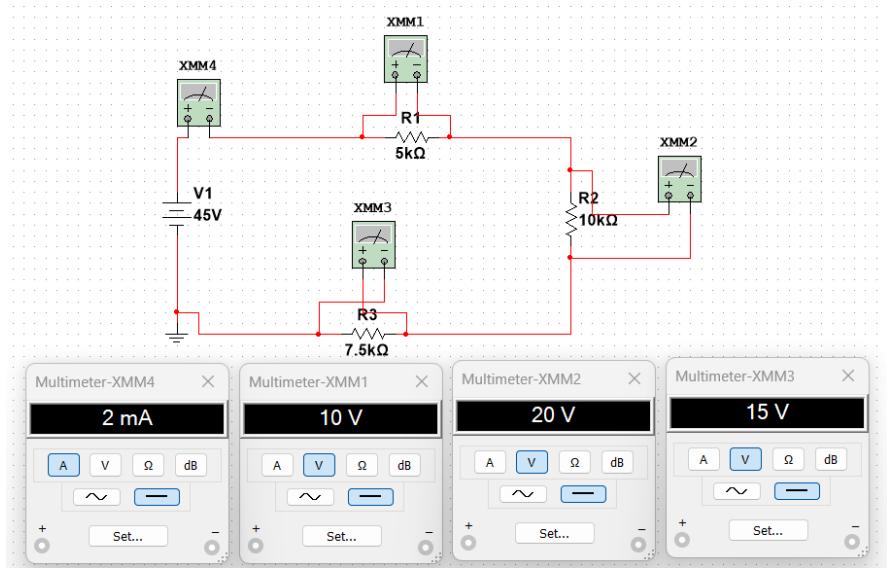
- Voltage across R_2 :

$$V_{R_2} = I_{total} \times R_2 = 2\text{ mA} \times 10\text{ k}\Omega = 20\text{ V}$$

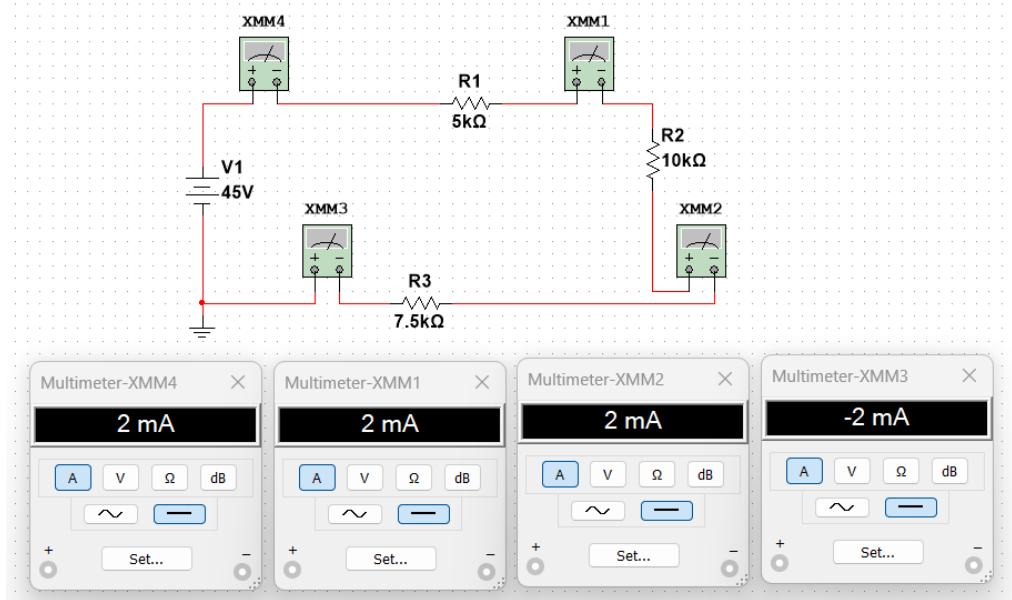
- Voltage across R_3 :

$$V_{R_3} = I_{total} \times R_3 = 2\text{ mA} \times 7.5\text{ k}\Omega = 15\text{ V}$$

NI Multisim Simulation Result: Voltage Division



NI Multisim Simulation Result: Current Division

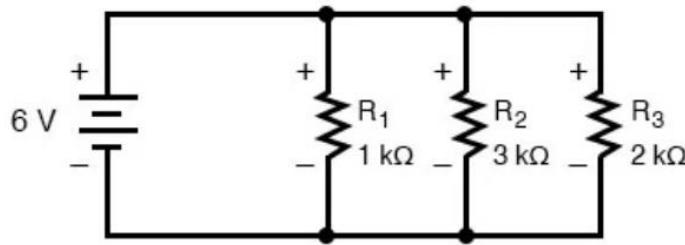


Case 02:

Analyze the given circuit where resistors $R_1=1\text{k}\Omega$, $R_2=3\text{k}\Omega$, and $R_3=2\text{k}\Omega$ are connected in parallel to a 6V DC source.

Instructions:

- Simulate the circuit on MATLAB/Simulink or NI Multisim to verify your calculated values.
- Report the simulated equivalent resistance, currents through each resistor, and total current, then compare them with your calculated values.



Step 1: Apply Voltage Division Rule

In a parallel circuit, the voltage across each resistor is the same as the voltage across the source.

- Voltage across R_1 :

$$V_{R_1} = V = 6 \text{ V}$$

- Voltage across R_2 :

$$V_{R_2} = V = 6 \text{ V}$$

- Voltage across R_3 :

$$V_{R_3} = V = 6 \text{ V}$$

Step 2: Apply Current Division Rule

Next, we calculate the current through each resistor using Ohm's Law:

- Current through R_1 :

$$I_{R_1} = \frac{V}{R_1} = \frac{6 \text{ V}}{1 \text{ k}\Omega} = 6 \text{ mA}$$

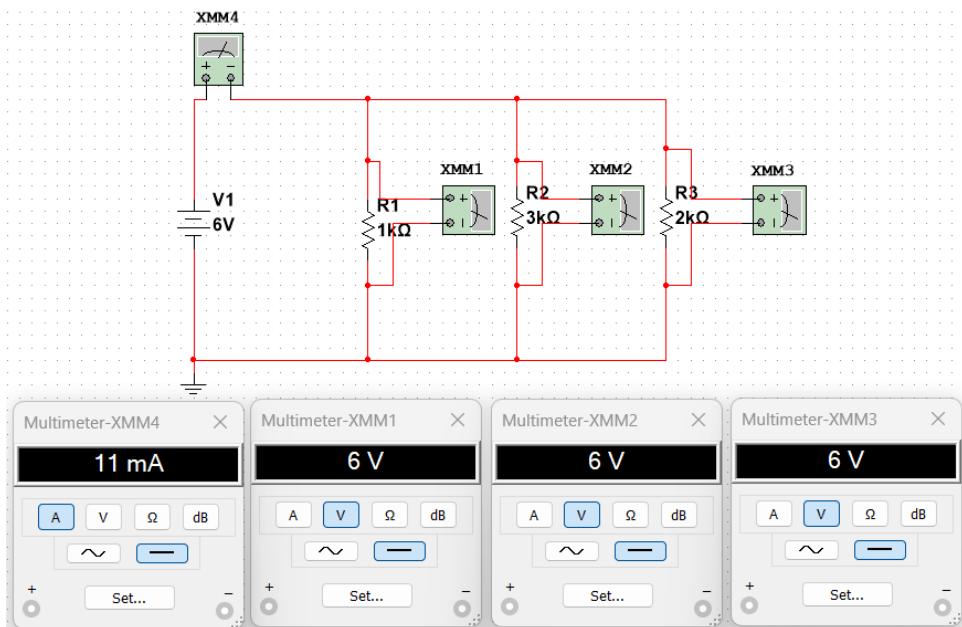
- Current through R_2 :

$$I_{R_2} = \frac{V}{R_2} = \frac{6 \text{ V}}{3 \text{ k}\Omega} = 2 \text{ mA}$$

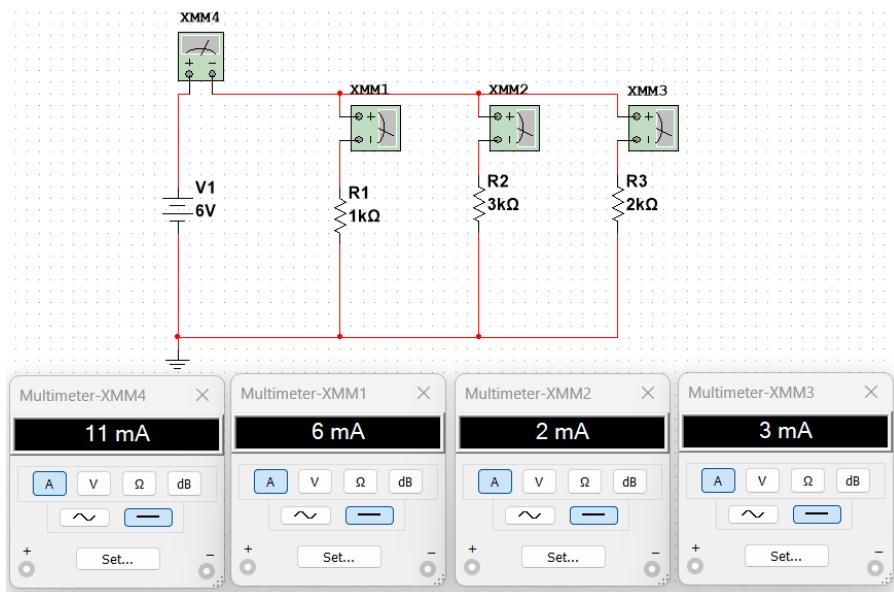
- Current through R_3 :

$$I_{R_3} = \frac{V}{R_3} = \frac{6 \text{ V}}{2 \text{ k}\Omega} = 3 \text{ mA}$$

NI Multisim Simulation Result: Voltage Division



NI Multisim Simulation Result: Current Division



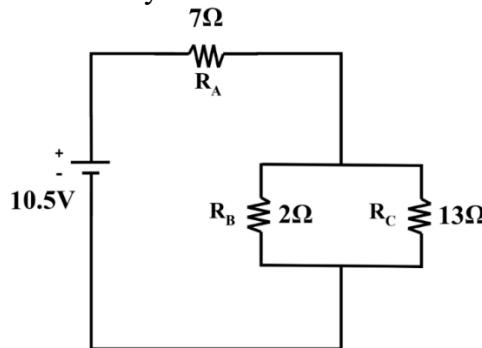
Component	Simulation Results				Theoretical Calculation Results			
	R1	R2	R3	V _{source}	R1	R2	R3	V _{source}
Voltage (V)	6 V	6 V	6 V	6 V	6 V	6 V	6 V	6 V
Current (mA)	6 mA	2 mA	3 mA	=11 mA	6 mA	2 mA	3 mA	I _{total} =I _{R1} +I _{R2} +I _{R3} =11 mA

Case 03:

Analyze the given circuit where resistors $R_A=7\ \Omega$, $R_B=2\ \Omega$, and $R_C=13\ \Omega$ are connected as shown in the circuit with a 10.5V DC source.

Instructions:

- Simulate the circuit on MATLAB/Simulink or NI Multisim to verify your calculated values.
- Report the simulated equivalent resistance, currents through each resistor, and total current, then compare them with your calculated values.



Step 1: Calculate Equivalent Resistance

Parallel Combination:

- R_B and R_C are in parallel:

$$\begin{aligned}\frac{1}{R_{BC}} &= \frac{1}{R_B} + \frac{1}{R_C} = \frac{1}{2\ \Omega} + \frac{1}{13\ \Omega} \\ \frac{1}{R_{BC}} &= \frac{13+2}{26} = \frac{15}{26}\ \Omega \\ R_{BC} &= \frac{26}{15}\ \Omega \approx 1.733\ \Omega\end{aligned}$$

Total Resistance:

The total resistance of the circuit is the sum of R_A and R_{BC} since they are in series:

$$R_{Total} = R_A + R_{BC} = 7\ \Omega + 1.733\ \Omega = 8.733\ \Omega$$

Step 2: Calculate the Total Current using Ohm's Law

$$I_{Total} = \frac{V}{R_{Total}} = \frac{10.5V}{8.733\ \Omega} \approx 1.202\ A$$

Step 3: Apply Voltage Division Rule

- Voltage across R_A :

$$V_{R_A} = I_{Total} \times R_A = 1.202\ A \times 7\ \Omega = 8.414\ V$$

- Voltage across R_{BC} :

$$V_{R_{BC}} = I_{Total} \times R_{BC} = 1.202\ A \times 1.733\ \Omega \approx 2.086\ V$$

Step 4: Apply Current Division Rule

Now, let's calculate the current through R_B and R_C using the current division rule.

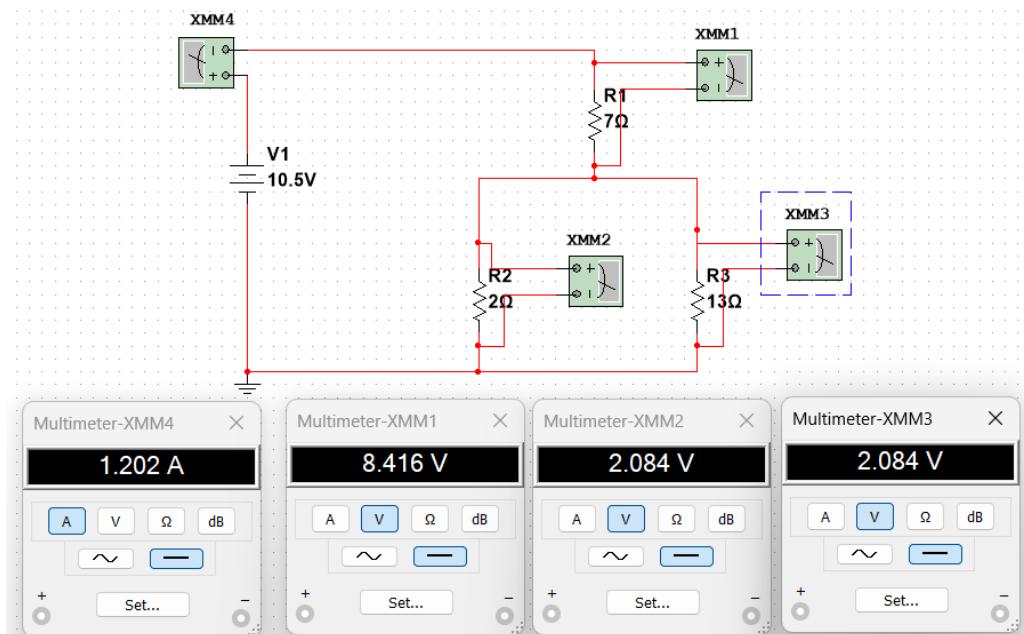
- Current through R_B :

$$I_{R_B} = \frac{R_C}{R_B + R_C} \times I_{Total} = \frac{13\Omega}{2\Omega + 13\Omega} \times 1.202 A \approx 1.040 A$$

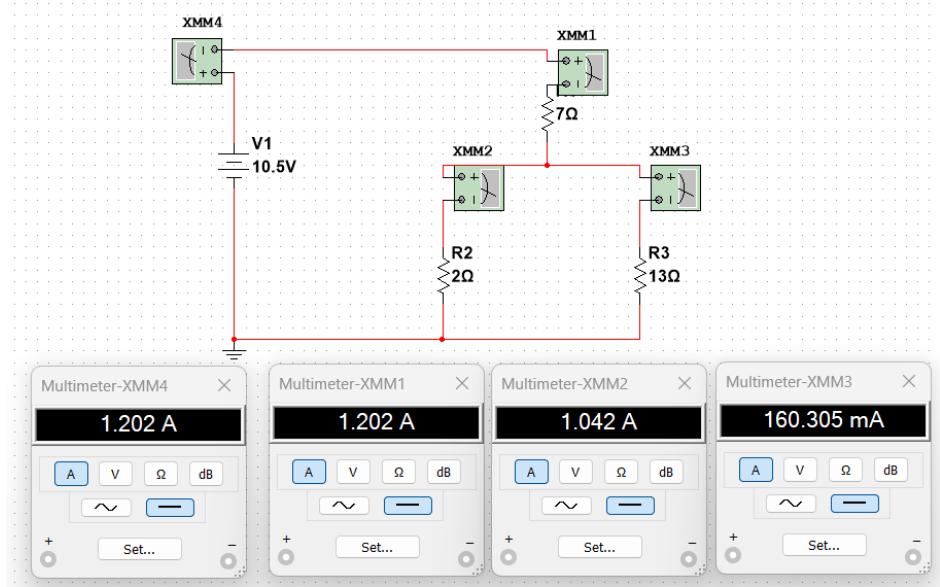
- Current through R_C :

$$I_{R_C} = \frac{R_B}{R_B + R_C} \times I_{Total} = \frac{2\Omega}{2\Omega + 13\Omega} \times 1.202 A \approx 0.162 A$$

NI Multisim Simulation Result: Voltage Division



NI Multisim Simulation Result: Current Division



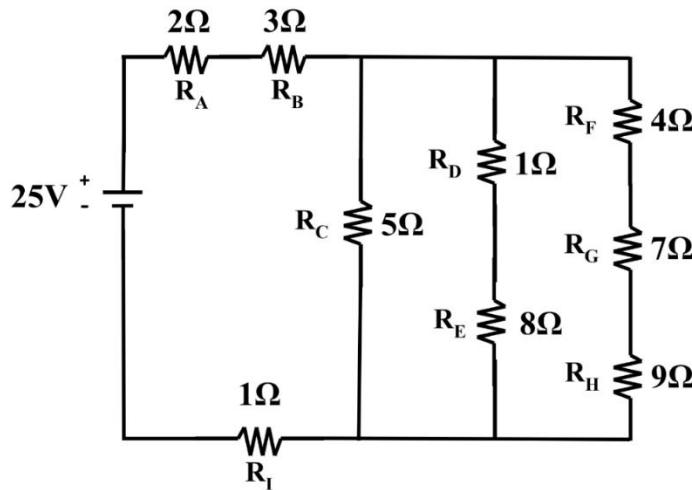
	Simulation Results				Theoretical Calculation Results			
Component	RA	RB	RC	Vsource	RA	RB	RC	Vsource
Voltage (V)	8.414 V	2.086 V	2.086 V	10.5 V	8.414 V	2.086 V	2.086 V	10.5 V
Current (A)	1.202 A	1.040 A	0.162 A	1.202 A	1.202 A	1.040 A	0.162 A	1.202 A

Case 04:

Analyze the complex resistive circuit, resistors $R_A=2\Omega$, $R_B=3\Omega$, $R_C=5\Omega$, $R_D=1\Omega$, $R_E=8\Omega$, $R_F=4\Omega$, $R_G=7\Omega$, $R_H=9\Omega$, and $R_I=1\Omega$ are arranged as shown, with a 25V DC power supply.

Instructions:

- Simulate the circuit on MATLAB/Simulink or NI Multisim to verify your calculated values.
- Report the simulated equivalent resistance, currents through each resistor, and total current, then compare them with your calculated values.



Step 1: Calculate Equivalent Resistances

Series Combinations:

1. R_D and R_E are in series:

$$R_{DE} = R_D + R_E = 1\Omega + 8\Omega = 9\Omega$$

2. R_F , R_G , and R_H are in series:

$$R_{FGH} = R_F + R_G + R_H = 4\Omega + 7\Omega + 9\Omega = 20\Omega$$

Parallel Combination:

Now, R_C , R_{DE} , and R_{FGH} are in parallel:

$$\frac{1}{R_{Total_Parallel}} = \frac{1}{R_C} + \frac{1}{R_{DE}} + \frac{1}{R_{FGH}}$$

$$\frac{1}{R_{Total_Parallel}} = \frac{1}{5\Omega} + \frac{1}{9\Omega} + \frac{1}{20\Omega}$$

$$R_{Total_Parallel} = \frac{1}{\left(\frac{1}{5} + \frac{1}{9} + \frac{1}{20}\right)} \approx 2.857\Omega$$

Total Resistance:

The total resistance of the circuit, which includes R_A , R_B , R_I , and $R_{Total_Parallel}$, is given by:

$$R_{Total} = R_A + R_B + R_I + R_{Total_Parallel} = 2\Omega + 3\Omega + 1\Omega + 2.857\Omega \approx 8.857\Omega$$

Step 2: Calculate the Total Current using Ohm's Law

$$I_{Total} = \frac{V}{R_{Total}} = \frac{25V}{8.857\Omega} \approx 2.822A$$

Step 3: Apply Voltage Division Rule

- Voltage across R_A :

$$V_{R_A} = I_{Total} \times R_A = 2.822A \times 2\Omega = 5.644V$$

- Voltage across R_B :

$$V_{R_B} = I_{Total} \times R_B = 2.822A \times 3\Omega = 8.466V$$

- Voltage across R_I :

$$V_{R_I} = I_{Total} \times R_I = 2.822A \times 1\Omega = 2.822V$$

- Voltage across $R_{Total_Parallel}$ (which will be the same for R_C , R_{DE} , and R_{FGH}):

$$V_{Parallel} = I_{Total} \times R_{Total_Parallel} = 2.822A \times 2.857\Omega \approx 8.068V$$

Step 4: Verify Voltage Division

- Sum of individual voltages:

$$V_{Total} = V_{R_A} + V_{R_B} + V_{R_I} + V_{Parallel} = 5.644V + 8.466V + 2.822V + 8.068V \approx 25V$$

This confirms the Voltage Division Rule.

Step 5: Apply Current Division Rule

Now, let's apply the Current Division Rule to the parallel section R_C , R_{DE} , and R_{FGH} .

- Current through R_C :

$$I_{R_C} = \frac{V_{Parallel}}{R_C} = \frac{8.068V}{5\Omega} \approx 1.614A$$

- Current through R_{DE} :

$$I_{R_{DE}} = \frac{V_{Parallel}}{R_{DE}} = \frac{8.068V}{9\Omega} \approx 0.896A$$

- Current through R_{FGH} :

$$I_{R_{FGH}} = \frac{V_{Parallel}}{R_{FGH}} = \frac{8.068 V}{20 \Omega} \approx 0.403 A$$

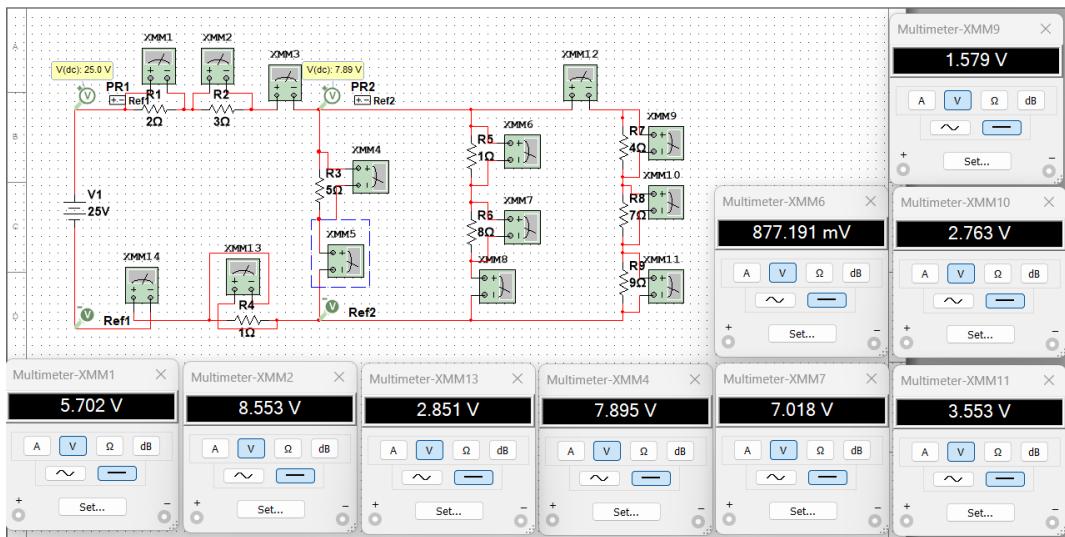
Step 6: Verify Current Division

- Sum of currents through parallel branches:

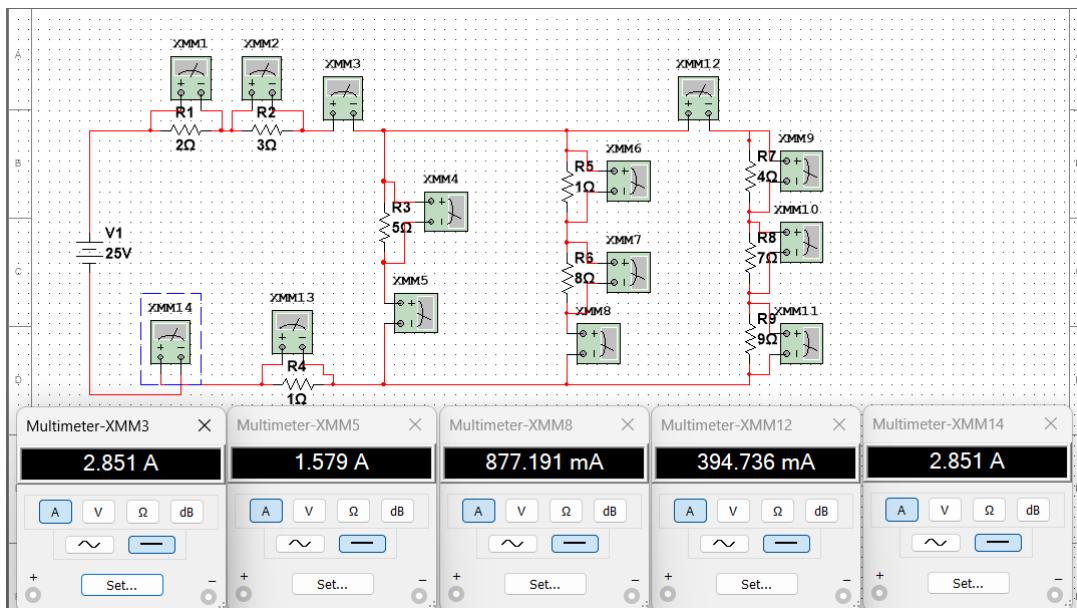
$$I_{Parallel_Sum} = I_{RC} + I_{RDE} + I_{R_{FGH}} = 1.614 A + 0.896 A + 0.403 A \approx 2.913 A$$

This value is slightly higher than the total current calculated earlier (2.822 A) due to rounding in earlier steps. However, this generally verifies the Current Division Rule.

Ni Multisim Simulation Results: KVL



Ni Multisim Simulation Results: KVL



Simulation Results					Theoretical Calculation Results					
RA	RB	RI	RC RDE IRFGH	Vsource	RA	RB	RC	RC RDE IRFGH	Vsource	
5.702V	8.553V	2.851V	7.895V	25	5.644V	8.466V	2.822V	8.068	25	
IRC	IRDE	IRFGH	I Total		IRC	IRDE	IRFGH	I Total		
1.579A	0.8772A	0.395A	2.851A		1.614A	0.896A	0.403A	2.913A		

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

Expt. No. 03	Verification of star delta transformation Using Resistance Reduction Technique
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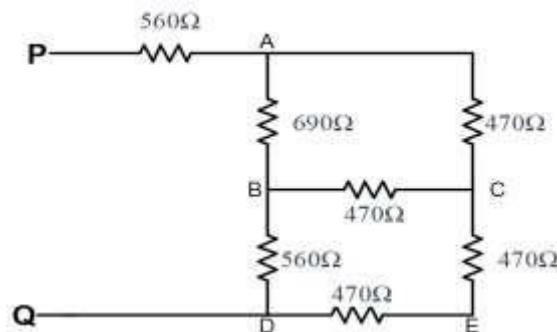
AIM:

To calculate the equivalent circuit resistance using star delta transformation technique.

APPARATUS REQUIRED:

S.No.	Apparatus Name	Range	Quantity
1	Resistor		
2	Bread board & Connecting wires	--	Required

CIRCUIT DIAGRAM:



PROCEDURE:

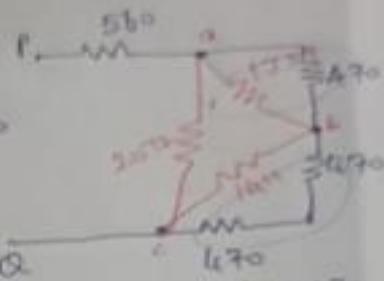
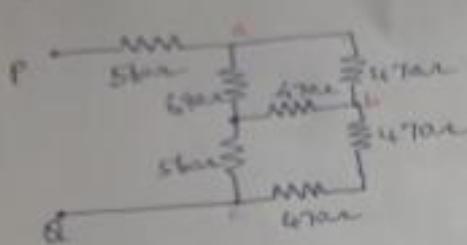
1. Give the connections as per the circuit diagram.
2. Determine the equivalent resistance of the circuit between P and Q using star – delta transformation technique
3. Verify the same by connecting Multimeter across PQ

OBSERVATIONS:

S.No.	Theoretical value (R_{PQ}) in ohm	Measured value(R_{PQ}) in ohm
1	1204	1200

Theoretical Calculations:

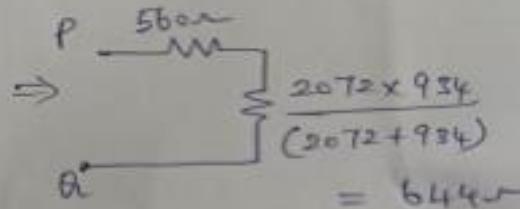
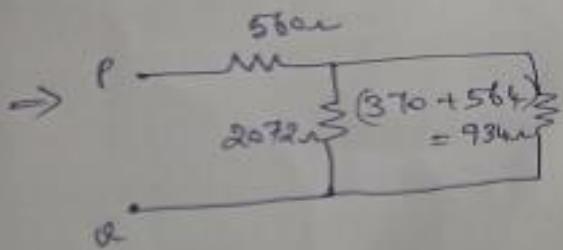
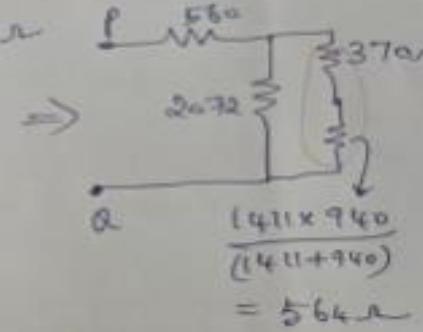
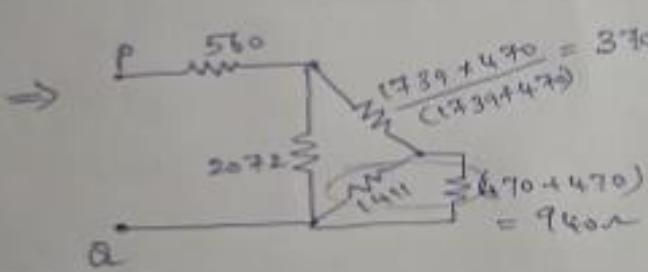
i) Star Delta Transformation



$$R_{ab} = R_a + R_b + \frac{R_a R_b}{R_c} = 690 + 470 + \frac{690 \times 470}{1739} = 1739 \Omega$$

$$R_{bc} = 470 + 560 + \frac{470 \times 560}{690} = 1411 \Omega$$

$$R_{ca} = 560 + 690 + \frac{560 \times 690}{470} = 2072 \Omega$$



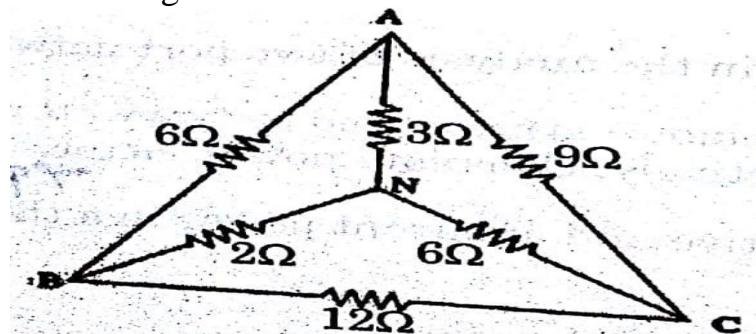
$$\therefore R_{PQ} = 560 + 644$$

$$\boxed{R_{PQ} = 1204 \Omega}$$

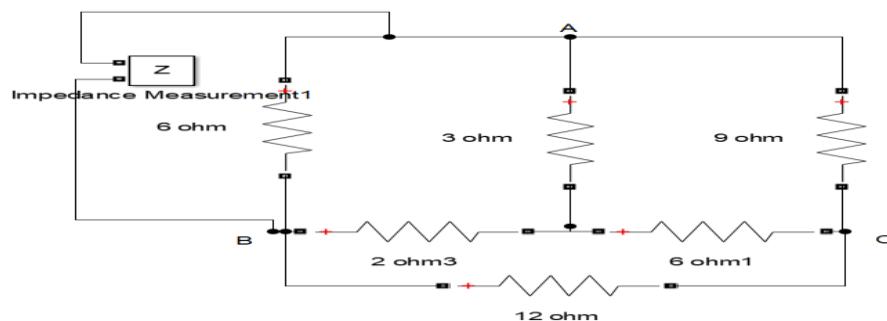
RESULT:

Thus the equivalent circuit resistance is obtained using star delta transformation technique.

Test Case 1: Design a MATLAB Simulink model to find the effective resistance between A&B using star delta transformation.



Simulink Model:



Theoretical Calculations:

Test Case 1:

$$R_{AB} = ?$$

$$R_{AN} = 3 + 2 + \frac{3 \times 2}{6} = 6\Omega$$

$$R_{BN} = 2 + 6 + \frac{2 \times 6}{3} = 12\Omega$$

$$R_{CN} = 6 + 3 + \frac{6 \times 3}{2} = 12\Omega$$

$$\Rightarrow \frac{6 \times 3}{(6+12)} = 6\Omega \quad \Rightarrow \frac{9 \times 12}{(9+12)} = 6\Omega \quad \Rightarrow \frac{6}{6+6} = 1\Omega$$

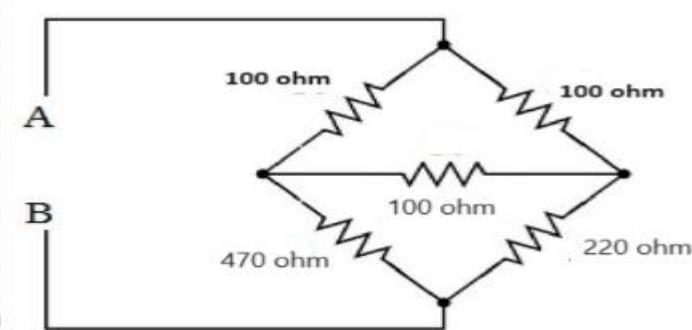
$$R_{AB} = \frac{3 \times 12}{(3+12)} = 2.4\Omega$$

OBSERVATIONS:

S.No.	Theoretical value (R_{PQ}) in ohm	Measured value in MATLAB (R_{PQ}) in ohm
1	2.4	2

Test Case 2: Design a circuit to verify star delta reduction technique for the bridge circuit shown below. Calculate the effective resistance between the terminals A & B theoretically and practically.

Circuit Diagram



Theoretical Calculations:

Test Case : 2

$$R_a = \frac{R_{ab} \cdot R_{ca}}{\sum R_{ab}} = \frac{100 \times 100}{300} = 33.33 \Omega$$

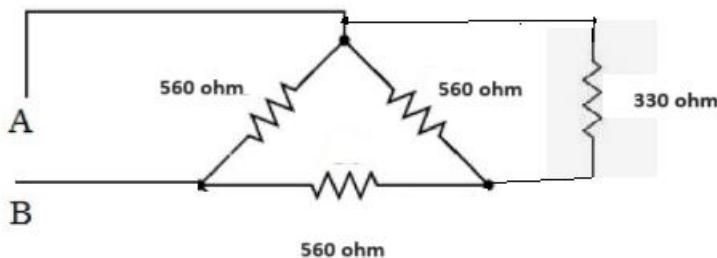
$$\therefore R_{AB} = 33.33 + 168.5 = 201.85 \Omega$$

OBSERVATIONS:

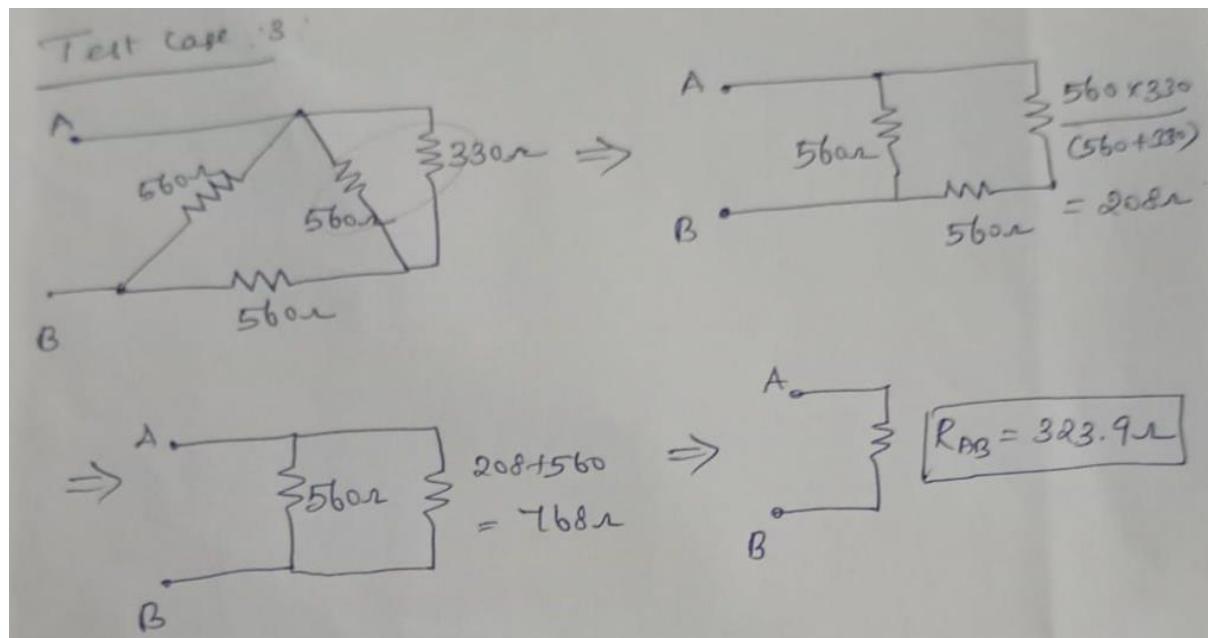
S.No.	Theoretical value (R _{PQ}) in ohm	Measured value(R _{PQ}) in ohm
1	201.85	198

Test Case 3: Design a circuit to verify star delta reduction technique for the circuit shown below. Calculate the effective resistance between the terminals A & B theoretically and practically.

Circuit Diagram



Theoretical Calculations:

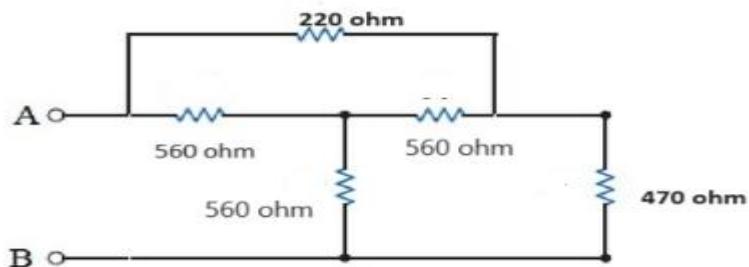


OBSERVATIONS:

S.No.	Theoretical value (R _{PQ}) in ohm	Measured value(R _{PQ}) in ohm
1	323.9	315

Test Case 4: Design a circuit to verify star delta reduction technique for the circuit shown below. Calculate the effective resistance between the terminals A & B theoretically and practically.

Circuit Diagram



Theoretical Calculations:

Test case 4

$$R_{PQ} = 560 + 560 + \frac{560 \times 560}{560} = 1680 \Omega$$

$$\frac{1680 \times 220}{(1680+220)} = 195 \Omega$$

$$\frac{1680 \times 470}{(1680+470)} = 367 \Omega$$

$$\Rightarrow A - [1680 \Omega] \parallel [195 + 367] = 562 \Omega$$

$$\therefore R_{AB} = \frac{1680 \times 562}{(1680+562)} \Rightarrow R_{AB} = 421 \Omega$$

OBSERVATIONS:

S.No.	Theoretical value (R _{PQ}) in ohm	Measured value(R _{PQ}) in ohm
1	421	412

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

Expt. No. 04	Verification of Thevenin's and Norton's Theorems
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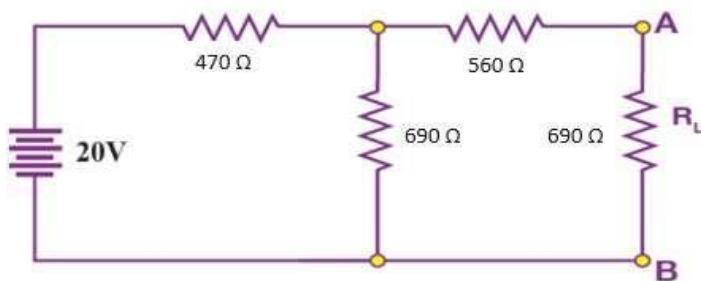
AIM:

To verify the equivalent circuit parameters of Thevenin's and Norton's Theorems theoretically and practically.

APPARATUS REQUIRED:

S.No.	Apparatus Name	Range	Quantity
1	DC Regulated Power Supply	(0-30)V	1
2	Voltmeter	(0-30)V	1
3	Ammeter	(0-200)mA	1
4	Resistor	$330\Omega, 220\Omega, 470 \Omega, 560 \Omega, 100 \Omega$	As required
5	Multimeter	-	1
6	Bread board & Connecting wires	--	As Required

CIRCUIT DIAGRAM:



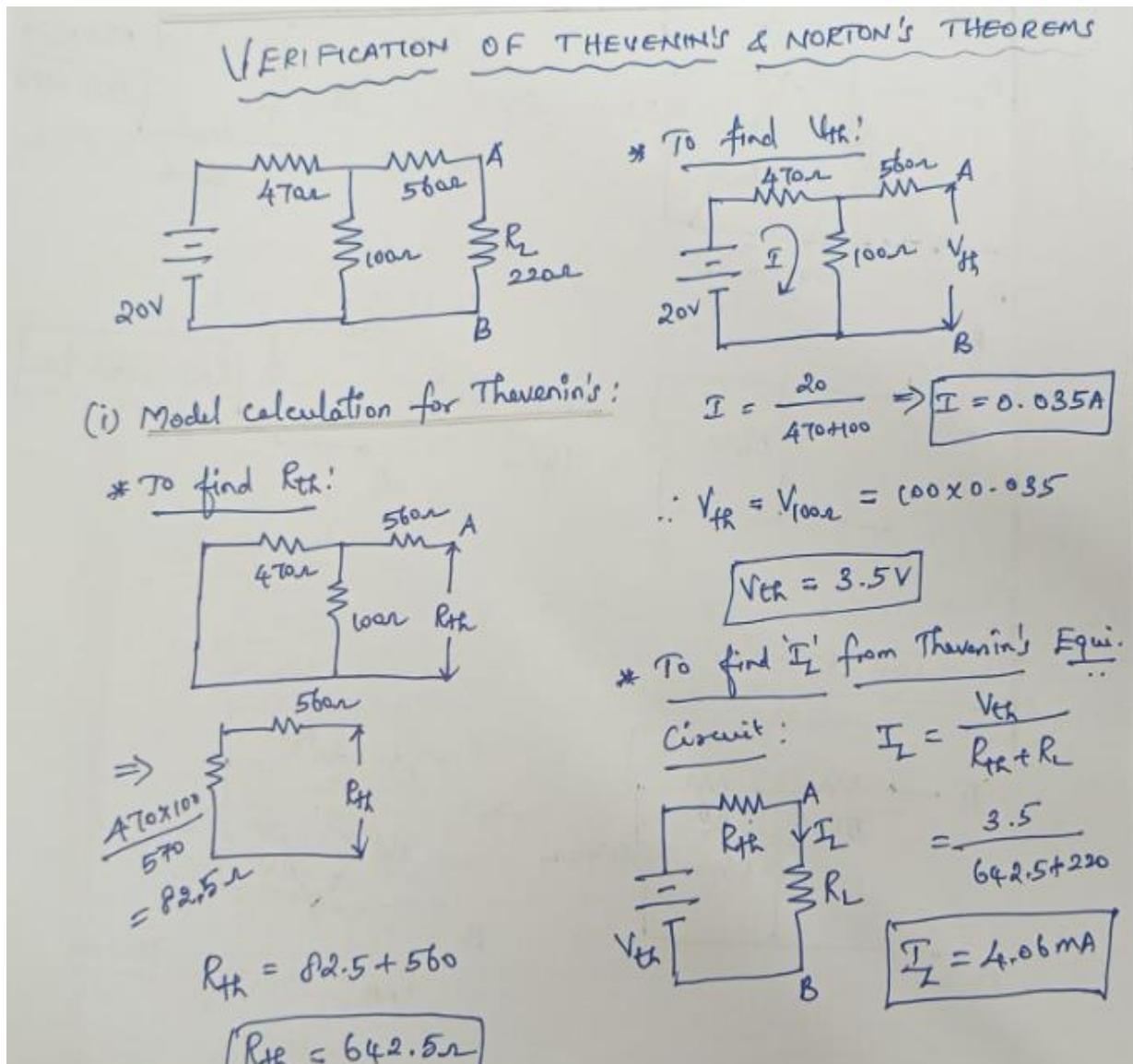
PROCEDURE FOR THEVENIN'S THEOREM:

1. Give the connections as per the circuit diagram.
2. Measure R_{th} using a multimeter by killing sources (O.C the current source and S.C the voltage source) and open circuit R_L .
3. Measure V_{th} across A & B (open circuit R_L)
4. Measure load current I_L through R_L .

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

5. Draw the Thevenin's Equivalent Circuit.

MODEL CALCULATION: THEVENIN'S THEOREM:



OBSERVATIONS:

S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(mA)$	$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(mA)$
1	20	642.5	3.5	4.06	640	3.5	4.0

PROCEDURE FOR NORTON'S THEOREM:

1. Give the connections as per the circuit diagram.
2. Measure R_{th} using a multimeter by killing sources (O.C the current source and S.C the voltage source) and open circuit R_L .
3. Measure I_N through A & B (Short circuit R_L)
4. Measure load current I_L through R_L .
5. Draw the Norton's Equivalent Circuit.

MODEL CALCULATION: NORTON'S THEOREM:

(ii) Model calculation for Norton's :

* $R_{th} = 642.5\Omega$ (Same as Thvenin's)

* To find I_{sc} or I_L :

$$I_T = \frac{V}{R_{eq}} = \frac{20}{554.85} = 0.036A$$

$$R_{eq} = 47 + (56 \parallel 100) = 554.85\Omega$$

$$I_{sc} = \frac{I_T}{R_{th}} \times R_{th} = \frac{0.036}{642.5} \times 642.5 = 5.455mA$$

$$I_L = \frac{(5.455 \times 10^{-3}) \times 642.5}{(642.5 + 20)} = 4.063mA$$

Norton's Equivalent circuit

By current division rule:

$$I_{sc} = I_{56\Omega} = \frac{I_T}{R_{th}} \times R_{th}$$

$$I_{sc} = \frac{0.036}{(100 + 56)} \times 100 = 5.455mA$$

OBSERVATIONS:

S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$I_{sc}(mA)$	$I_L(mA)$	$R_{th}(\Omega)$	$I_{sc}(mA)$	$I_L(mA)$
1	20	642.5	5.455	4.063	640	5.5	4.0

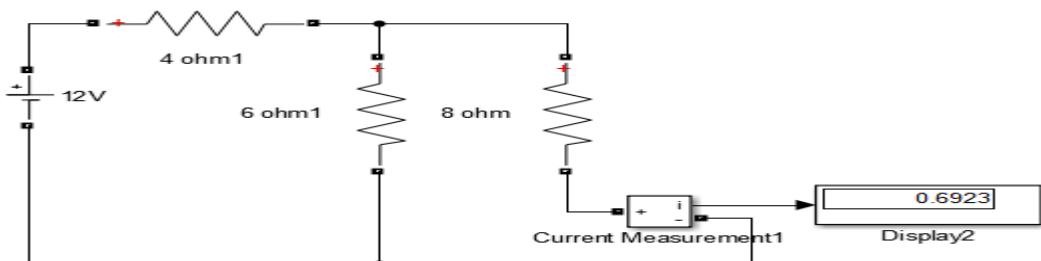
RESULT:

Thus the equivalent circuit parameters are obtained using Thevenin's and Norton's Theorem.

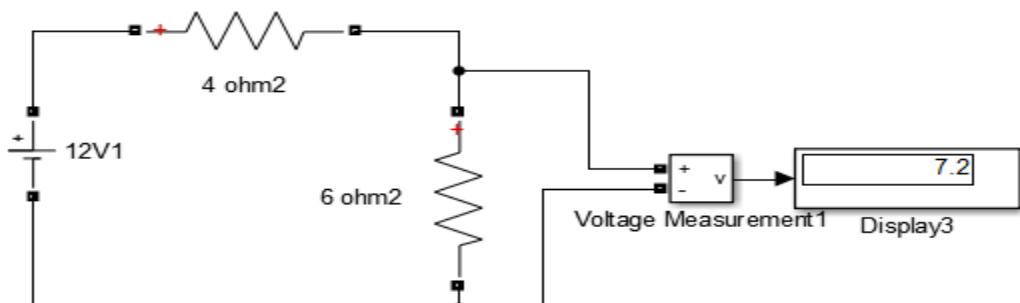
Test Case 1: A 12V voltage source is connected in series with two resistors, $R_1=4\Omega$ and $R_2=6\Omega$. The load resistor $R_L=8\Omega$ is connected across the terminals where Thevenin's equivalent is to be found. Verify the results using MATLAB SIMULINK.

MATLAB SIMULINK MODEL(THEVENIN'S):

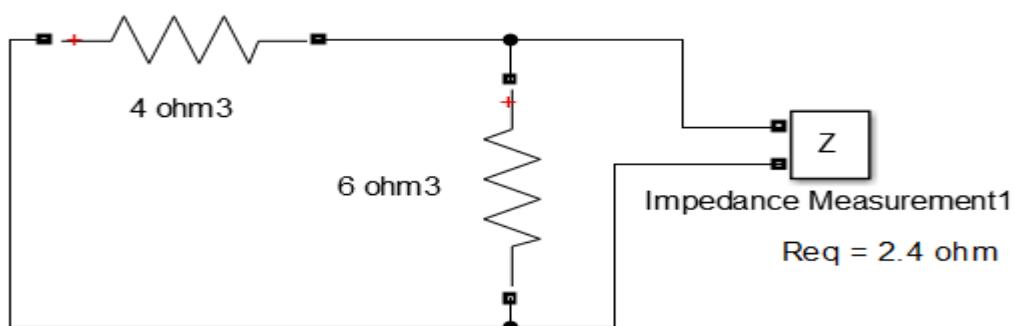
To find I_L :



To find V_{th} :



To find R_{th} :

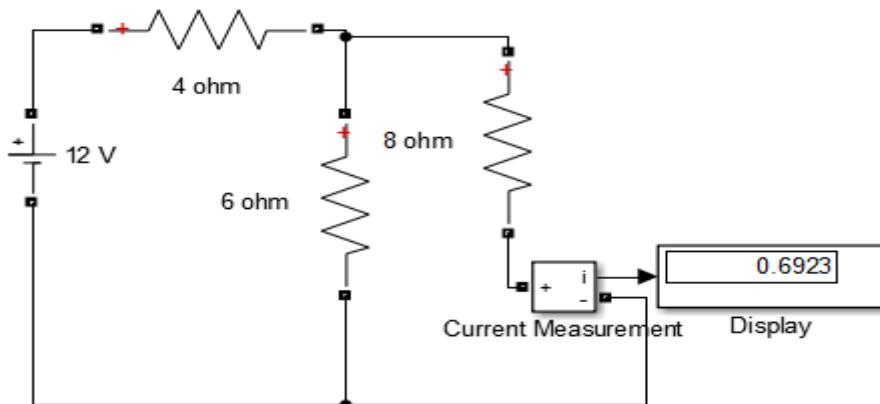


OBSERVATIONS:

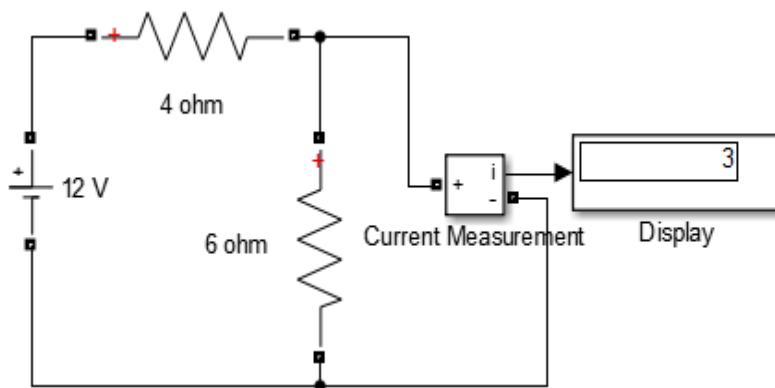
S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$	$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$
1	12	2.4	7.2	0.72	2.4	7.2	0.6923

MATLAB SIMULINK MODEL (NORTON'S):

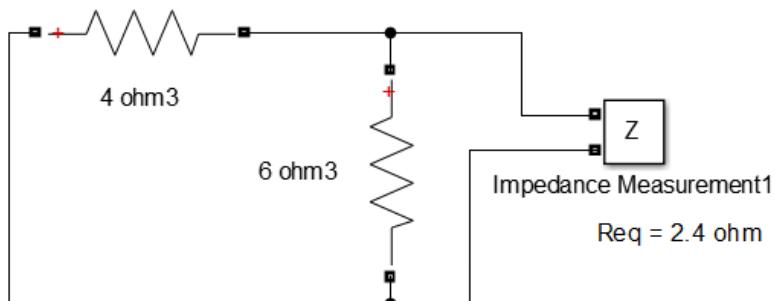
To find I_L :



To find I_{SC} :



To find R_{th} :

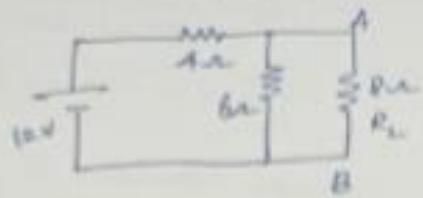


OBSERVATIONS:

S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$I_{SC}(\text{A})$	$I_L(\text{A})$	$R_{th}(\Omega)$	$I_{SC}(\text{A})$	$I_L(\text{A})$
1	12	2.4	1.2	0.692	2.4	3	0.6923

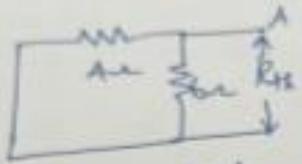
MODEL CALCULATION:

TEST CASE : 1



(i) Model calculation for 'Thomson':

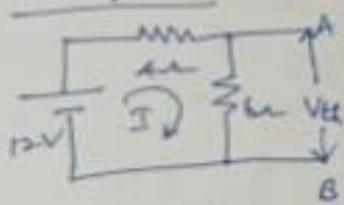
- * To find R_{th} : Remove R_L (a.c.)
i.e. the 'V' source



$$R_{th} = \frac{4 \times 6}{4+6}$$

$$R_{th} = 2.4\Omega$$

- * To find V_{th} :

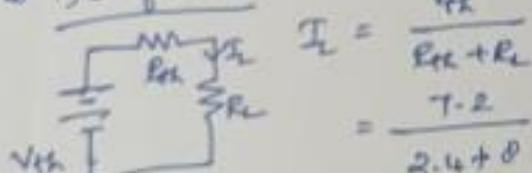


$$I = \frac{12}{4+6} = 1.2A$$

$$\therefore V_{th} = V_{6\Omega} = 6I$$

$$V_{th} = 7.2V$$

- * To find I_L :



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

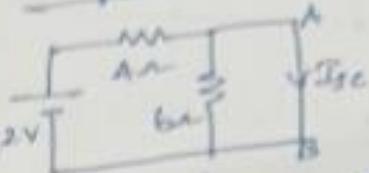
$$= \frac{7.2}{2.4 + 8}$$

$$I_L = 0.72A$$

(ii) Model Calculation for Norton's

- * $R_{sc} = 2.4\Omega$ (same as Thomson)

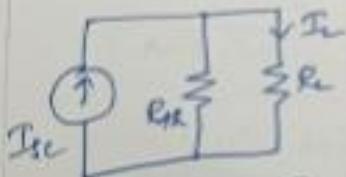
- * To find I_{sc}



$$I_{sc} = \frac{12}{2.4} = 5A$$

$$I_{sc} = 5A$$

- * Norton's Equivalent Circuit
to find I_L :

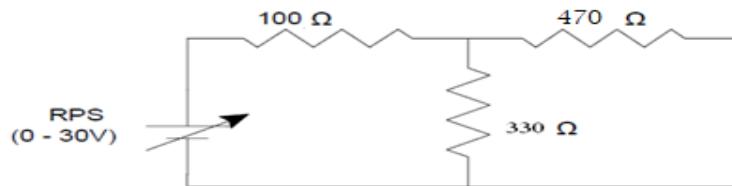


$$I_L = \frac{I_{sc} \cdot R_L}{R_{th} + R_L}$$

$$I_L = \frac{5 \times 2.4}{(2.4 + 8)}$$

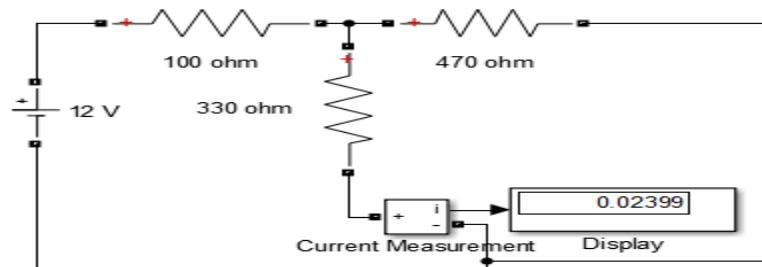
$$I_L = 0.692A$$

Test Case 2: Determine the current flows through 330Ω resistor by applying Thevenin's & Norton's theorem theoretically and Verify the results using MATLAB SIMULINK. Assume 12V supply.

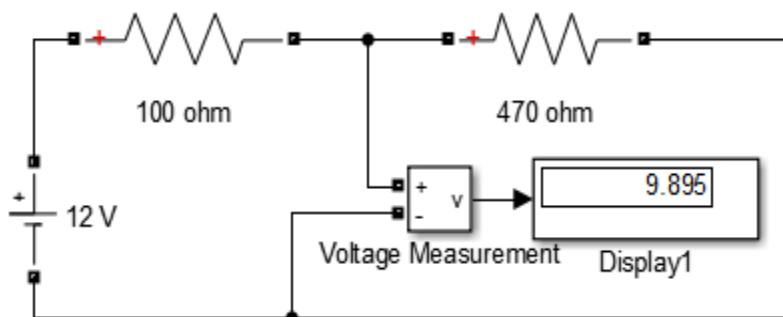


MATLAB SIMULINK MODEL(THEVENIN'S):

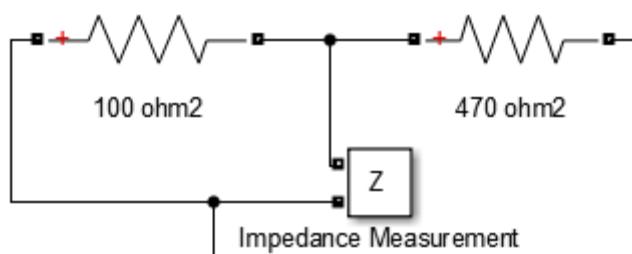
To find I_L :



To find V_{th} :



To find R_{th} :

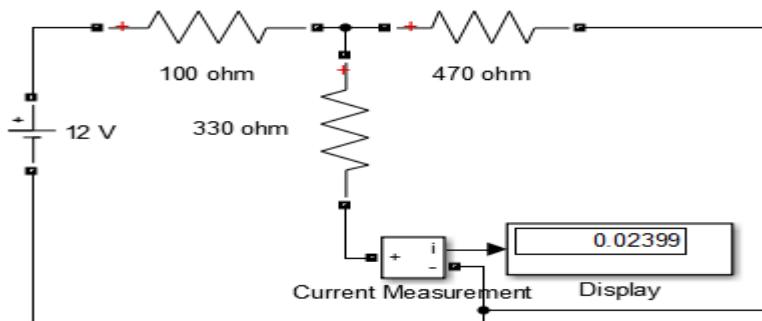


OBSERVATIONS:

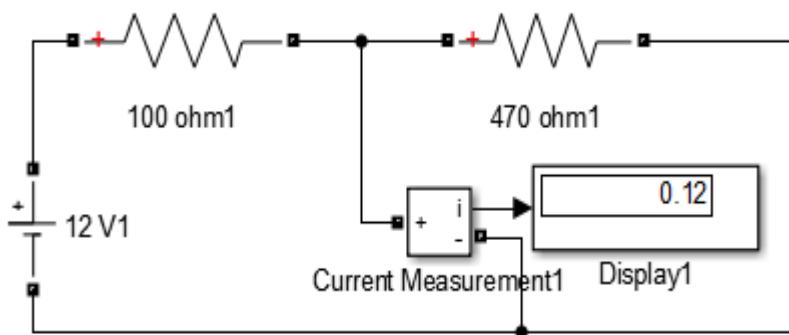
S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$	$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$
1	12	82.46	9.87	0.024	82.46	9.895	0.02399

MATLAB SIMULINK MODEL (NORTON'S):

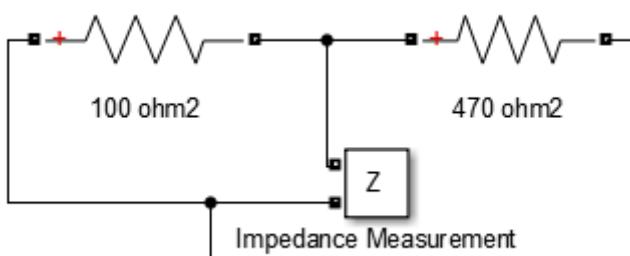
To find I_L :



To find I_{SC} :



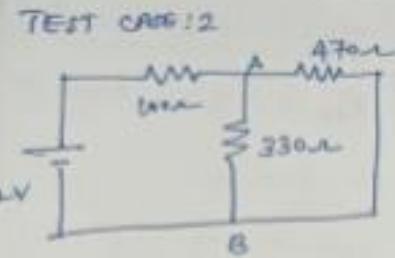
To find R_{th} :



OBSERVATIONS:

S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$I_{SC}(A)$	$I_L(A)$	$R_{th}(\Omega)$	$I_{SC}(A)$	$I_L(A)$
1	12	82.46	0.12	0.024	82.46	0.12	0.02399

MODEL CALCULATION:

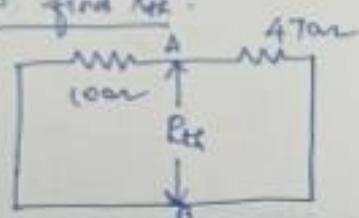


$$I_L = \frac{9.9}{82.46 + 330}$$

$$I_L = 0.024 \text{ A} = 24 \text{ mA}$$

(i) Model calculation for Thévenin's

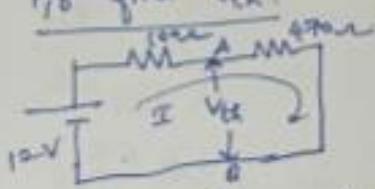
* To find R_{th} :



$$R_{th} = \frac{100 \times 470}{100 + 470}$$

$$R_{th} = 82.46 \Omega$$

* To find V_{th} :



$$(100 + 470) I = 12$$

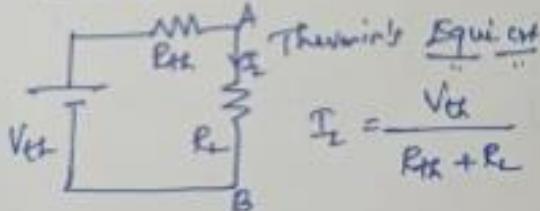
$$I = 0.021 \text{ A}$$

$$V_{th} = 12 - 100I = 9.9 \text{ V}$$

(or)

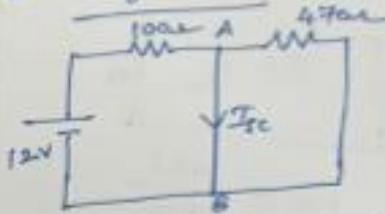
$$V_{th} = 470I = 9.87 \text{ V}$$

* To find I_L :



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

* To find I_{sc} :

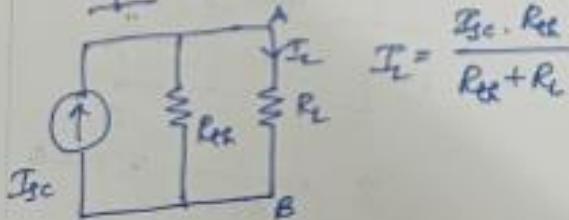


$$I_{sc} = \frac{12}{100} = 0.12 \text{ A}$$

$$I_{sc} = 0.12 \text{ A}$$

* To find I_L from Norton's

Equiv. cat

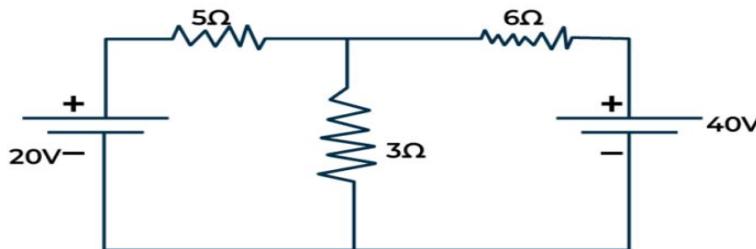


$$I_L = \frac{I_{sc} \cdot R_L}{R_{th} + R_L}$$

$$I_L = \frac{0.12 \times 82.46}{82.46 + 330}$$

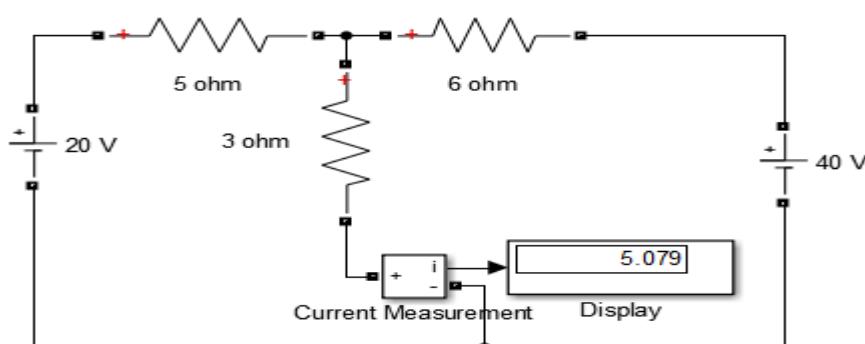
$$I_L = 0.024 \text{ A} \\ = 24 \text{ mA}$$

Test Case 3: Determine the current flows through 3Ω resistor by applying Thevenin's & Norton's theorem theoretically and Verify the results using MATLAB SIMULINK. Assume 20V supply.

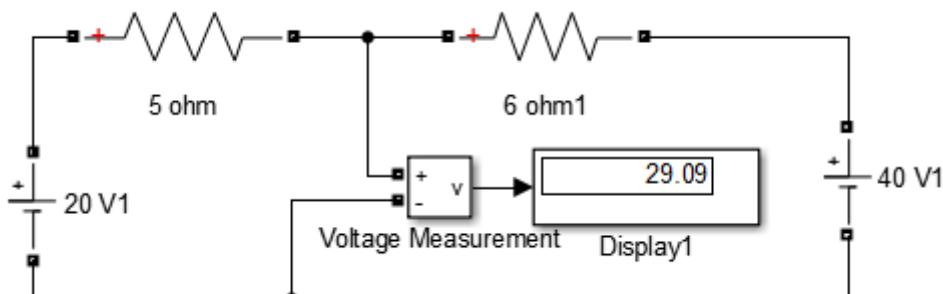


MATLAB SIMULINK MODEL (THEVENIN'S):

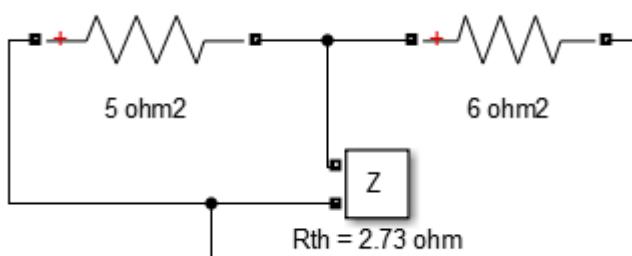
To find I_L :



To find V_{th} :



To find R_{th} :

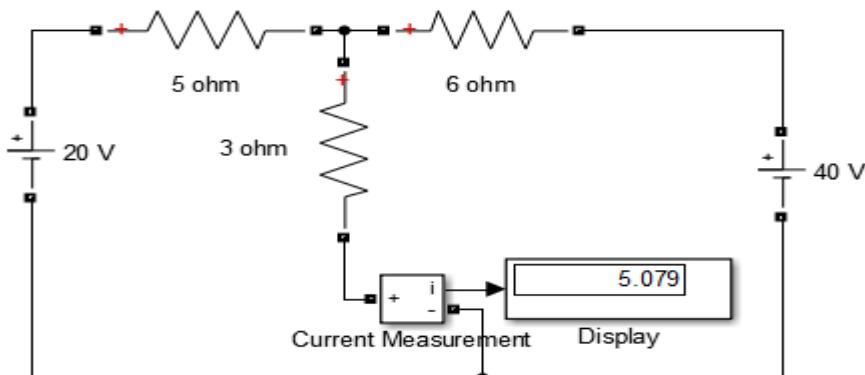


OBSERVATIONS:

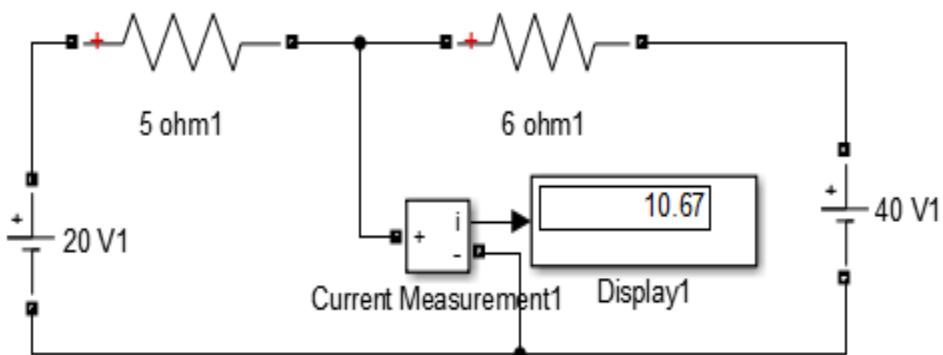
S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$	$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$
1	20V and 40 V	2.73	29.1	1.9	2.73	29.09	5.079

MATLAB SIMULINK MODEL (NORTON'S):

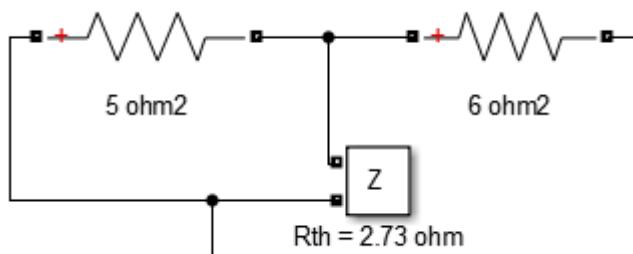
To find I_L :



To find I_{SC} :



To find R_{th} :

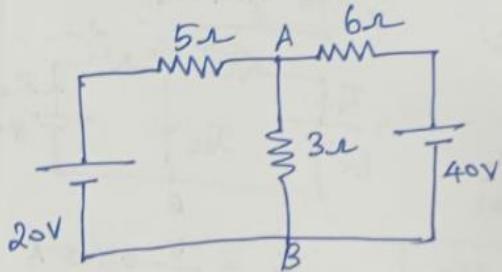


OBSERVATIONS:

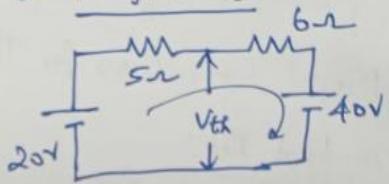
S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$I_{SC}(A)$	$I_L(A)$	$R_{th}(\Omega)$	$I_{SC}(A)$	$I_L(A)$
1	20V and 40 V	2.73	10.67	5.08	2.73	10.67	5.079

MODEL CALCULATION:

TEST CASE : 3



* To find V_{th} :



$$\text{II } I = \frac{20 - 40}{5}$$

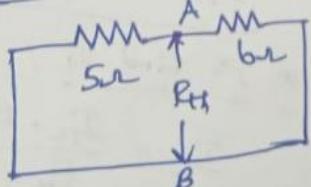
$$I = \frac{-20}{5} \Rightarrow I = -1.82 \text{ A}$$

$$\therefore V_{th} = 20 - 5 \cdot (-1.82)$$

$$V_{th} = 29.1 \text{ V}$$

(i) Model calculation for Thvenin's:

* To find R_{th} :



$$R_{th} = \frac{5 \times 6}{(5+6)}$$

$$R_{th} = 2.73 \Omega$$

* To find I_L :

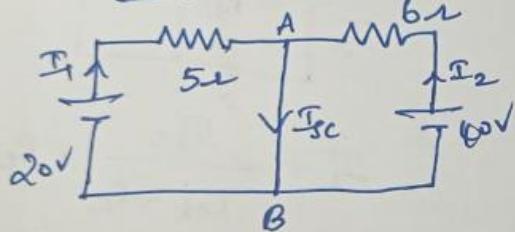
$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{29.1}{(2.73 + 3)}$$

$$I_L = 5.08 \text{ A}$$

(ii) Model calculation for Norton's:

$$* R_{th} = 2.73 \Omega \text{ (as Thvenin's)}$$

* To find I_{sc} :



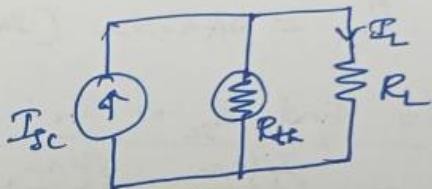
$$I_1 = \frac{20}{5} = 4 \text{ A}$$

$$I_2 = \frac{40}{6} = 6.67 \text{ A}$$

$$\therefore I_{sc} = I_1 + I_2$$

$$I_{sc} = 10.67 \text{ A}$$

* To find I_L :



$$I_L = \frac{I_{sc} \cdot R_{th}}{R_{th} + R_L}$$

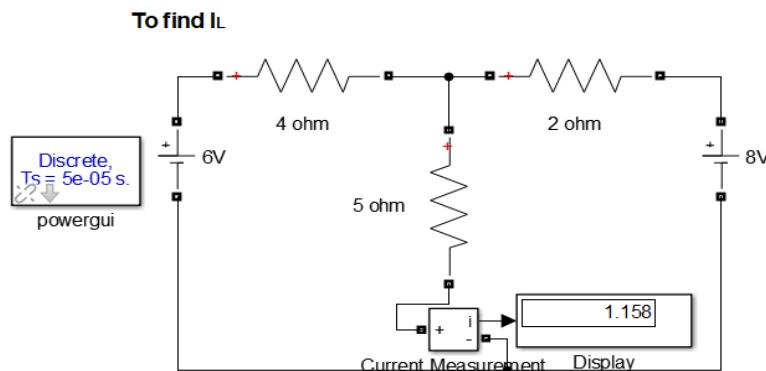
$$= \frac{10.67 \times 2.73}{(2.73 + 3)}$$

$$I_L = 5.08 \text{ A}$$

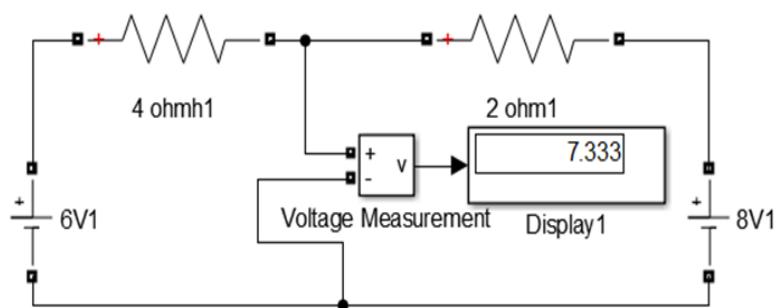
Test Case 4: Determine the current flows through 5Ω resistor by applying Thevenin's & Norton's theorem theoretically and practically.

MATLAB SIMULINK MODEL (THEVENIN'S):

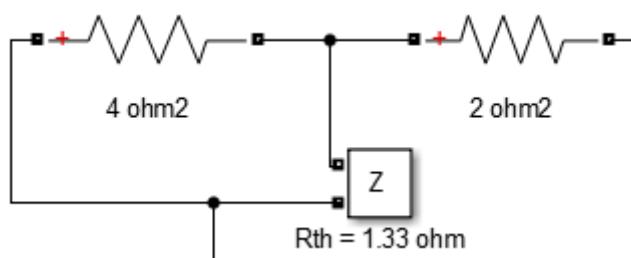
To find I_L :



To find V_{th} :



To find R_{th} :

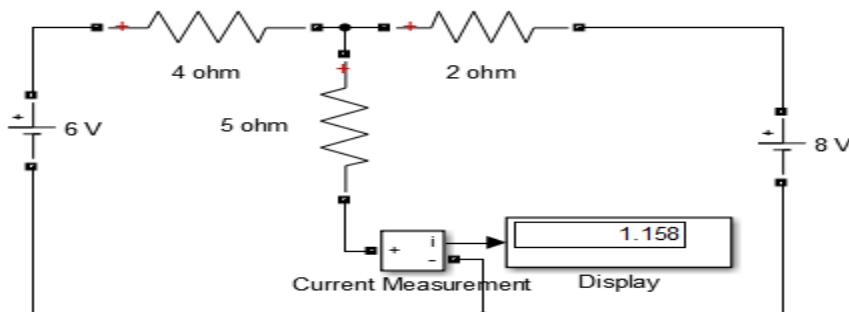


OBSERVATIONS:

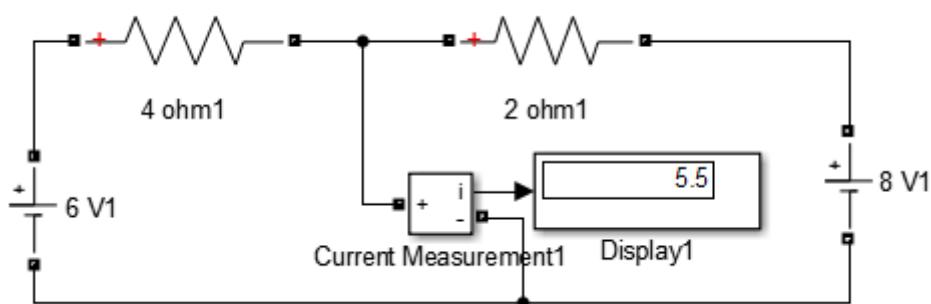
S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$	$R_{th}(\Omega)$	$V_{th}(V)$	$I_L(A)$
1	6V and 8V	1.33	7.32	1.156	1.33	7.333	1.158

MATLAB SIMULINK MODEL (NORTON'S):

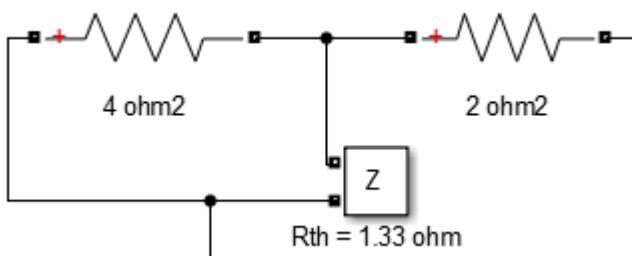
To find I_L :



To find I_{SC} :



To find R_{th} :

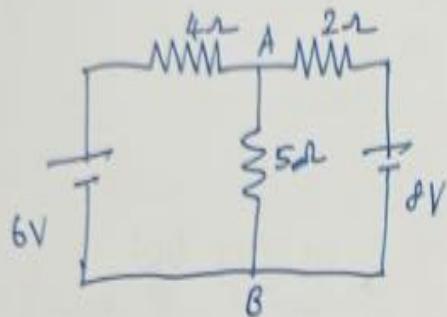


OBSERVATIONS:

S.No.	Supply Voltage (V)	Theoretical values			Measured values		
		$R_{th}(\Omega)$	$I_{SC}(A)$	$I_L(A)$	$R_{th}(\Omega)$	$I_{SC}(A)$	$I_L(A)$
1	6V and 8V	1.33	5.5	1.16	1.33	5.5	1.158

MODEL CALCULATION:

TEST CASE: 4

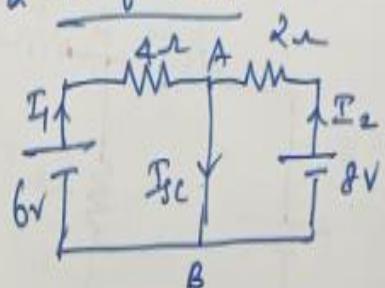


$$I_L = 1.156 \text{ A}$$

(ii) Model Calculation for Norton's

* $R_{TH} = 1.33 \Omega$ (as Thévenin)

* To find I_{SC} :

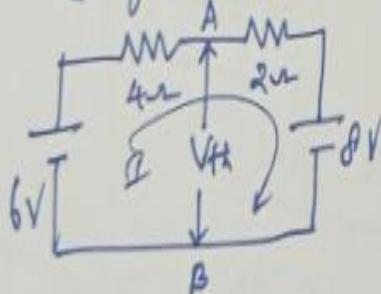


$$I_1 = \frac{6}{4} = 1.5 \text{ A}$$

$$I_2 = \frac{8}{2} = 4 \text{ A}$$

$$I_{SC} = I_1 + I_2 = 5.5 \text{ A}$$

* To find V_{TH} :



$$6I = 6 - 8$$

$$I = -0.33 \text{ A}$$

$$V_{TH} = 6 - 4I$$

$$V_{TH} = 7.32 \text{ V}$$

* To find I_L :

$$I_L = \frac{V_{TH}}{R_{TH} + R_L} = \frac{7.32}{(1.33 + 5)}$$

* To find I_L :

$$I_L = \frac{I_{SC} \cdot R_L}{R_{TH} + R_L}$$

$$= \frac{5.5 \times 1.33}{(1.33 + 5)}$$

$$I_L = 1.16 \text{ A}$$

Expt. No. 05	Verification of Maximum Power Transfer theorem and Superposition theorem
---------------------	---------------------------------------------------------------------------------

5(a). Verification of Maximum Power Transfer

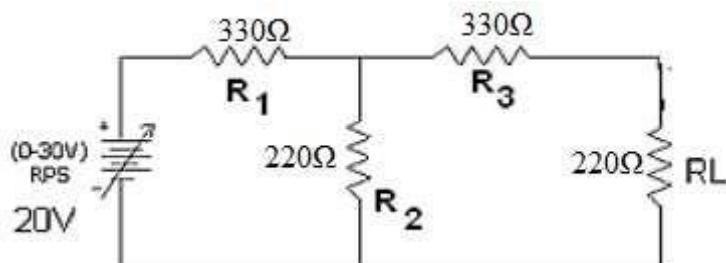
Theorem AIM:

To verify Maximum Power Transfer Theorem

APPARATUS REQUIRED:

S.No.	Apparatus Name	Range	Quantity
1	DC Regulated Power Supply	(0-30)V	1
2	Voltmeter	(0-30)V	1
3	Ammeter	(0-200)mA	1
4	Resistor	330Ω, 220Ω	Each two
5	Multimeter	-	1
6	Bread board & Connecting wires	--	Required

CIRCUIT DIAGRAM:



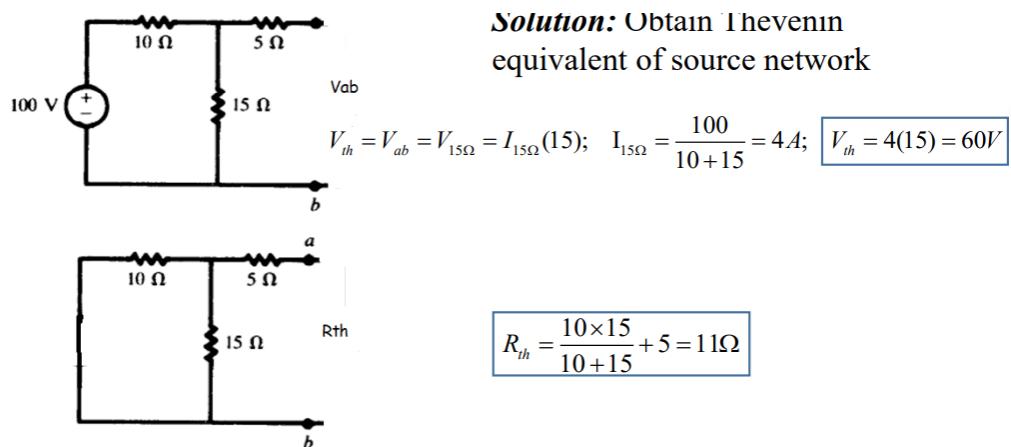
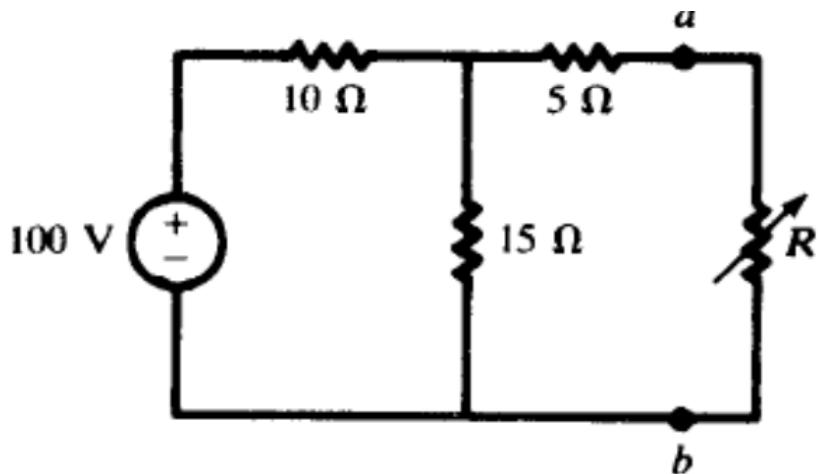
PROCEDURE:

1. Give the connections as per the circuit diagram.
2. Measure R_{th} using a multimeter
3. Measure V_{th} across 220Ω (R_2)
4. Measure load current I_L through R_L
5. Calculate the maximum power transferred to the load

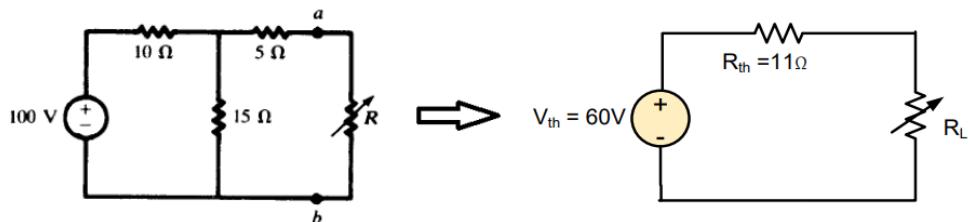
CALCULATION:

Case problems:

1. Find the value of the adjustable resistance R that dissipates the maximum power across terminals a-b. What is the maximum power that can be delivered to this load?



Thevenin equivalent is obtained, with $V_{th}=60V$ and $R_{th}=11\Omega$

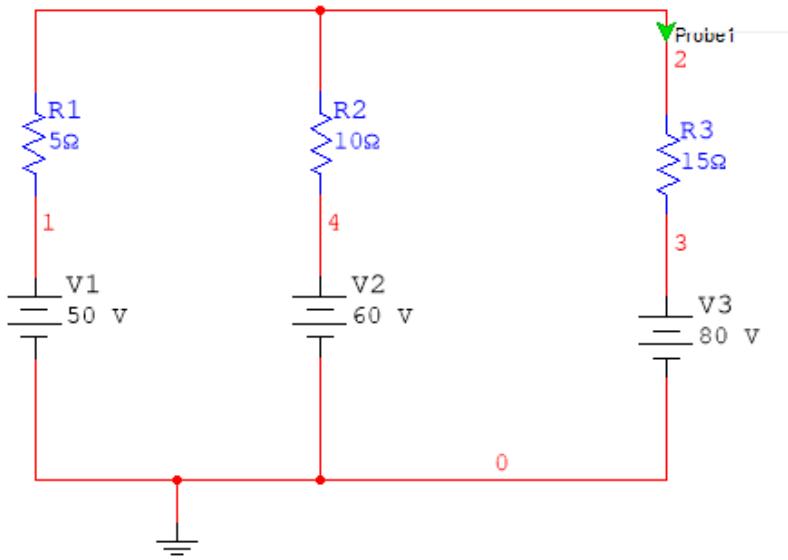


Maximum power transfer occurs for $R_L = R_{th} = 11\Omega$

Power delivered to the load is

$$P_{max} = i^2 R_L = \left(\frac{V_{Th}}{R_{th} + R_L} \right)^2 R_L = \frac{V_{Th}^2}{4R_{th}} = \frac{60^2}{4 \times 11} = 81.82W$$

2. Calculate the Maximum Power Transfer Theorem for given parallel network value
 $R_1=5$ ohms, $R_2=10$ ohms, $R_3=15$ ohms and parallel $v_1=50V$, $V_2=60V$ and $V_3=80V$.



$$1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3$$

$$1/R_{eq} = 1/5 \text{ ohms} + 1/10 \text{ ohms} + 1/15 \text{ ohms}$$

$$1/R_{eq} = 0.2 + 0.1 + 0.0667$$

$$1/R_{eq} = 0.3667$$

$$R_{eq} = 1 / 0.3667$$

$$R_{eq} \approx 2.7273 \text{ ohms}$$

Thevenin voltage (V_{th}):

$$V_{th} = v_1 + v_2 + v_3$$

$$V_{th} = 50V + 60V + 80V$$

$$V_{th} = 195V$$

$$I = V_{total} / R_{eq}$$

$$I = 190V / 2.7273 \text{ ohms}$$

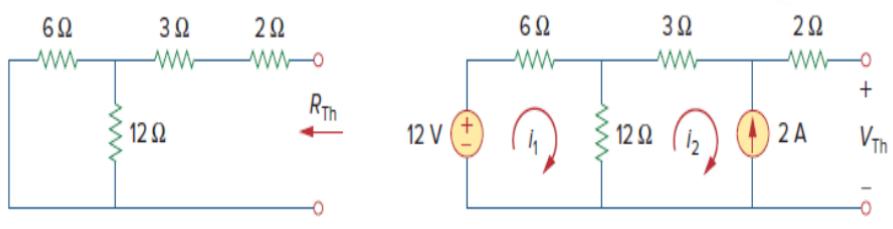
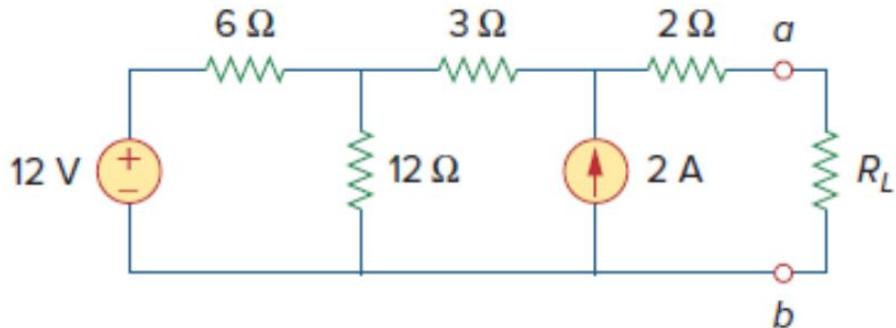
$$I \approx 69.6429 \text{ A}$$

$$P_{max} = (I^2) * R_{eq}$$

$$P_{max} = (69.6429 \text{ A})^2 * 2.7273 \text{ ohms}$$

$$P_{max} \approx 13287.2 \text{ watts}$$

3. Find the value of RL for maximum power transfer and compute the maximum power delivered



$$R_{Th} = 2 + 3 + 6 \parallel 12 = 5 + \frac{6 \times 12}{18} = 9\Omega \quad -12 + 18i_1 - 12i_2 = 0, \quad i_2 = -2A \\ \Rightarrow i_1 = -2/3.$$

KVL around the outer loop: $-12 + 6i_1 + 3i_2 + 2(0) + V_{Th} = 0 \Rightarrow V_{Th} = 22V$

For maximum power transfer,

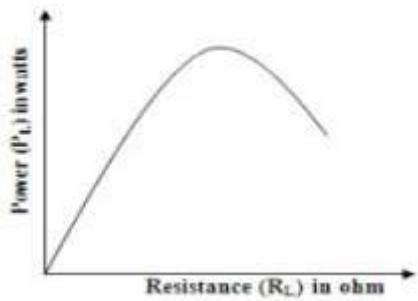
$$R_L = R_{Th} = 9 \Omega$$

The maximum power is,

$$P_{\max} = \frac{V_{Th}^2}{4R_L} = \frac{22^2}{4 \times 9} = 13.44W$$

OBSERVATIONS:

MODEL GRAPH:



RESULT:

Thus the Maximum Power Transfer Theorem is verified.

5(b). Verification of Superposition Theorem

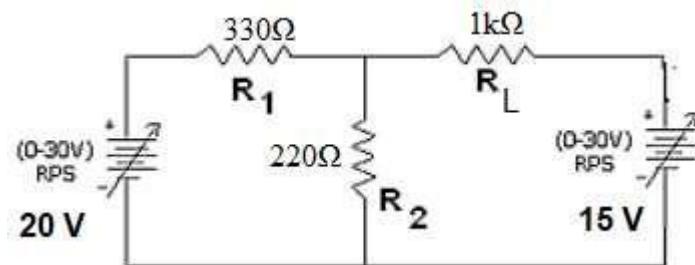
AIM:

To determine the current flow through the load resistor using Superposition Theorem

APPARATUS REQUIRED:

S.No.	Apparatus Name	Range	Quantity
1	DC Regulated Power Supply	(0-30)V	2
2	Voltmeter	(0-30)V	1
3	Ammeter	(0-200)mA	1
4	Resistor	1kΩ, 220Ω, 330 Ω	Each one
5	Multimeter	-	1
6	Bread board & Connecting wires	--	Required

CIRCUIT DIAGRAM:

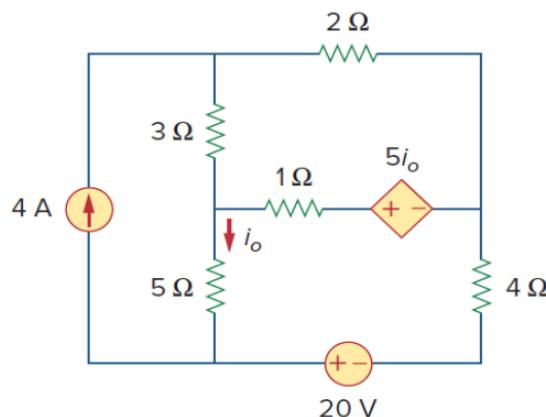


PROCEDURE:

1. Give the connections as per the circuit diagram.
2. Measure current flow through $1\text{k}\Omega$ by connecting both the supplies.
3. Short circuit 15 V source.
4. Measure current flow through $1\text{k}\Omega$ by connecting 20 V supply.
5. Short circuit 20 V source.
6. Measure current flow through $1\text{k}\Omega$ by connecting 15 V supply.
7. Verify the net current through $1\text{k}\Omega$ resistor.

Case no.

1. Find i_o in the circuit of Fig using superposition.



$$\text{Loop 1: } i_1 = 4 \text{ A} \quad (2)$$

$$3$$

$$\text{Loop 2: } -3i_1 + 6i_2 - 1i_3 - 5i_o' = 0 \quad (3)$$

$$\text{Loop 3: } -5i_1 - 1i_2 + 10i_3 + 5i_o' = 0 \quad (4)$$

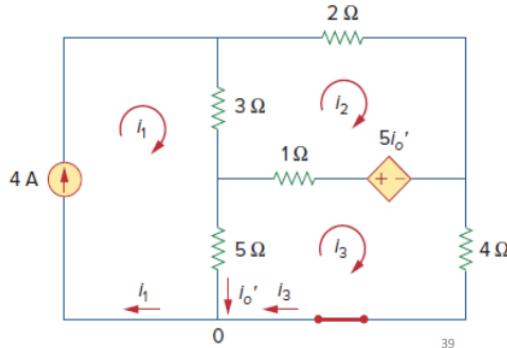
$$\text{Node 0: } i_3 = i_1 - i_o' = 4 - i_o' \quad (5)$$

Substituting (2) and (5) into (3) and (4) gives two simultaneous equations

$$3i_2 - 2i_o' = 8 \quad (6)$$

$$i_2 - 5i_o' = 20 \quad (7)$$

$$\Rightarrow i_o' = \frac{52}{17} \text{ A} \quad (8)$$



To obtain i_o'' we turn off the 4-A current source.

$$\text{KVL in upper loop: } 6i_4 - i_5 - 5i_o'' = 0 \quad (9)$$

$$\text{KVL in lower loop: } -i_4 + 10i_5 - 20 + 5i_o'' = 0 \quad (10)$$

But $i_5 = -i_o''$.

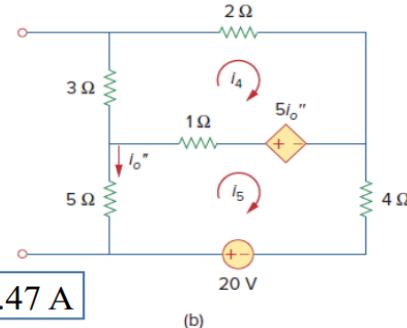
Substituting this in Eqs. (9) and (10) gives

$$6i_4 - 4i_o'' = 0 \quad (11)$$

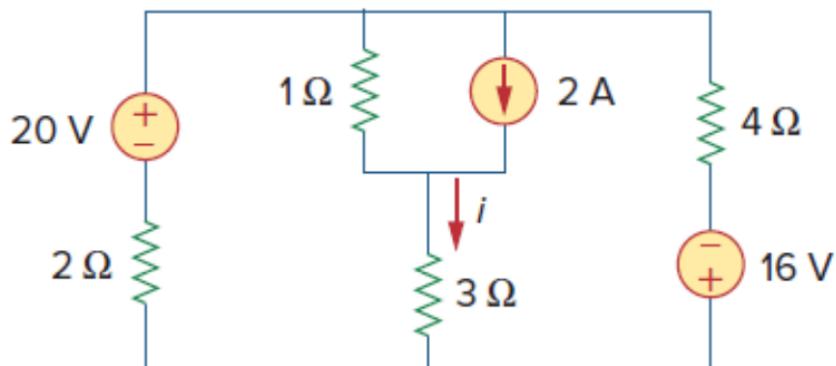
$$i_4 + 5i_o'' = -20 \quad (12)$$

$$\Rightarrow i_o'' = -\frac{60}{17} \text{ A} \quad (13)$$

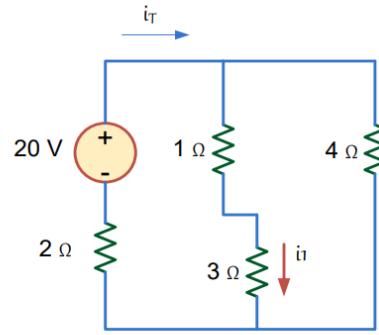
$$i_o = i_o' + i_o'' = (52 - 60)/17 = -8/17 = -0.47 \text{ A}$$



2. Use superposition to find current flowing through the 3-Ω resistor.



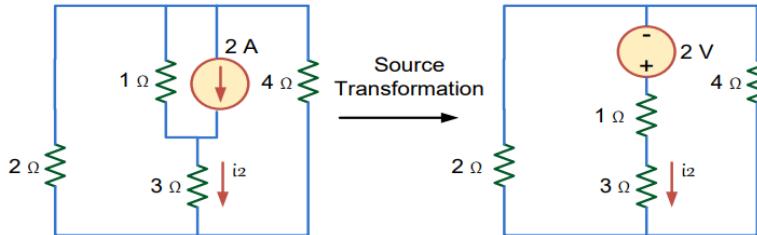
Solution: Since there are three sources, $i = i_1 + i_2 + i_3$



First consider 20V source only

$$R_{eq} = \frac{4 \times (3+1)}{4+3+1} + 2 = 4\Omega$$

$$i_T = \frac{20}{4} = 5A; \quad i_1 = \frac{5 \times 4}{1+3+4} = 2.5A \text{ (current division)}$$



$$R_{eq} = \frac{4 \times 2}{4+2} + 1 + 3 = 5.33\Omega$$

$$i_T = \frac{2}{5.33} = 0.375A; \quad i_2 = i_T = 0.375A$$

Finally consider 16V source only

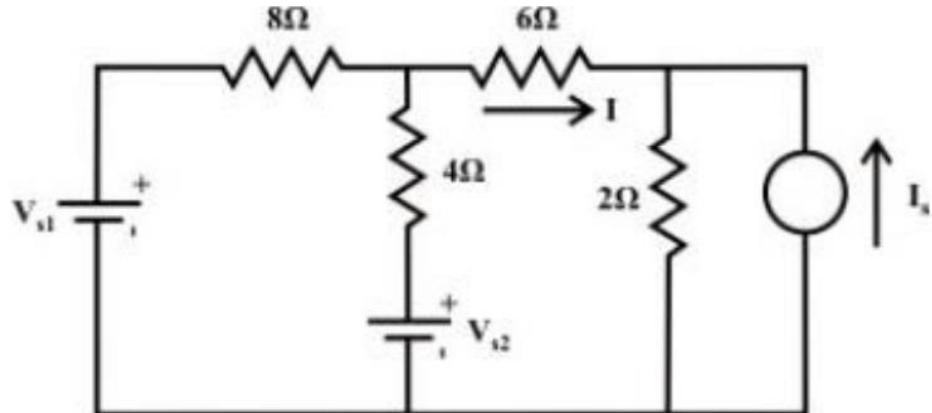
$$R_{eq} = \frac{4 \times 2}{4+2} + 1 + 3 = 5.33\Omega$$

$$i_T = \frac{16}{5.33} = 3A; \quad -i_3 = \frac{3 \times 2}{2+1+3} = 1A;$$

Current flowing through 3-Ω resistor is

$$i = i_1 + i_2 + i_3 = 2.5 + 0.375 - 1 = 1.875A$$

- 3 For the circuit shown in fig, the value of V_{s1} and I_s are fixed. When $V_{s2} = 0$, the current $I = 4A$. Find the value of I when $V_{s2} = 32V$



Solution: The current flowing through 6Ω resistor due to the voltage and current sources are given by (assuming circuit linearity):

$$I = I'(\text{due to } V_{s1}) + I''(\text{due to } V_{s2}) + I'''(\text{due to } I_s)$$

$$I = \alpha V_{s1} + \beta V_{s2} + \eta I_s \quad (1)$$

where, parameters α , β and η represent constants

When $V_{s2}=0$, $I = 4 \text{ A} \Rightarrow I = I'(\text{due to } V_{s1}) + I'''(\text{due to } I_s) = 4$

$$\Rightarrow I = \alpha V_{s1} + \eta I_s = 4 \quad (2)$$

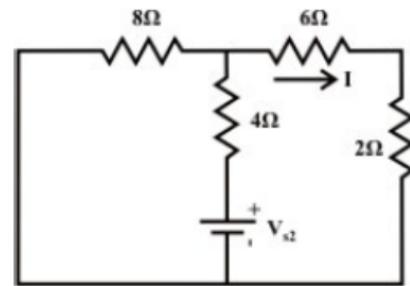
When $V_{s2} = 32 \text{ V}$ is acting alone: $I_T = \frac{V_{s2}}{R_{eq}} = \frac{32}{(8 \parallel 8) + 4} = 4 \text{ A}$

$$I_{vs2} = I'' = \frac{I_T \times 8}{8+8} \text{ (current division)} = \frac{4 \times 8}{16} = 2 \text{ A}$$

$$I'' = \beta V_{s2} = 2 \text{ A} \quad (3)$$

Current flow through 6Ω resistor
when $V_{s2} = 32 \text{ V}$ is

$$I = \alpha V_{s1} + \beta V_{s2} + \eta I_s = 4 + 2 = 6 \text{ A}$$



OBSERVATIONS:

S.No.	Measured Current (mA) through $1\text{k}\Omega$ when both supplies are connected	Calculated Current (mA) through $1\text{k}\Omega$		Measured Current (mA) through $1\text{k}\Omega$		Net current (mA)
		V= 20 V	V= 15 V	V= 20 V	V= 15 V	
1.						

RESULT:

Thus the current flow through the load resistor is determined using Superposition Theorem.

Experiment No.: 7

LOAD TEST ON SINGLE PHASE TRANSFORMER

Aim:

A load test on a single-phase transformer is conducted to evaluate the transformer's performance under full load conditions. The test helps determine the voltage regulation, efficiency, and overall behaviour of the transformer when it is delivering power to a load.

Apparatus required:

S. No.	Apparatus required	Range	Quantity
1	Single-phase transformer	1φ, (0-260)V	1
2	Voltmeter	(0-150)V (0-300) V MI type	1 Each
3	Ammeter	(0-10)A (0-5) A MI type	1 Each
4	Wattmeter	(300V, 5A) (150V, 5A) UPF	1 Each
5	Supply source (AC power source)		
6	Variable resistive load or a load bank	5KW, 230V	1
7	Connecting wires	As required	

Procedure:

1. Setup:

- a. Connect the primary winding of the transformer to the AC power source.
- b. Connect the secondary winding to a variable resistive load or load bank.
- c. Connect the voltmeter across the secondary winding to measure the secondary voltage.
- d. Connect the ammeter in series with the load to measure the load current.
- e. Connect the wattmeter to measure the power consumed by the load.

2. Adjust the Load:

- a. Start with no load on the secondary side and gradually increase the load by adjusting the variable resistor or load bank.

- b. Increase the load until the rated current flows through the secondary winding.

3. Record Readings:

- For each load setting, record the following:
 - Primary voltage (V_1)
 - Primary current (I_1)
 - Secondary voltage (V_2)
 - Secondary current (I_2)
 - Power consumed by the load (W)

4. Calculate Voltage Regulation:

- Voltage regulation is a measure of how much the secondary voltage drops from no-load to full-load conditions. It can be calculated using the formula:

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

$V_{\text{no load}}$ is the secondary voltage with no load, and $V_{\text{full load}}$ is the secondary voltage with full load.

5. Calculate Efficiency:

- Efficiency (η) of the transformer can be calculated using the formula:

$$\eta = \frac{P_{\text{output}}}{P_{\text{input}}} \times 100$$

- $P_{\text{output}} = V_{\text{load}} \times I_{\text{load}}$
- $P_{\text{input}} = P_{\text{output}} + P_{\text{losses}}$ where P_{losses} includes both copper and iron losses.

6. Analyse the Results:

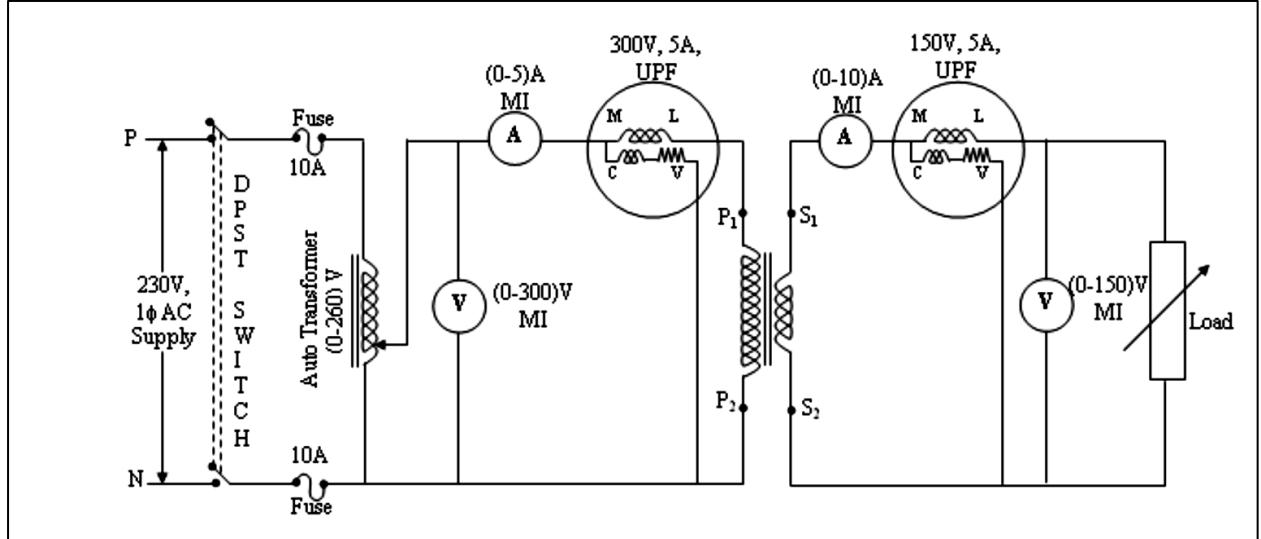
- Use the data collected to analyse the transformer's performance. Look for any significant drops in voltage or unexpected losses which could indicate issues with the transformer.

Precautions:

Ensure that the transformer and the equipment used for testing are properly rated for the test conditions.

- Be cautious while handling electrical equipment and ensure all connections are secure to avoid short circuits or shocks.
- Gradually increase the load to prevent sudden surges that could damage the transformer.

Circuit Diagram



Fuse Rating:

- Primary Fuse: 125% of 27.17 A \approx 34 A (choose a 35 A fuse)
- Secondary Fuse: 125% of 54.35 A \approx 68 A (choose a 70 A fuse)

Name late details:

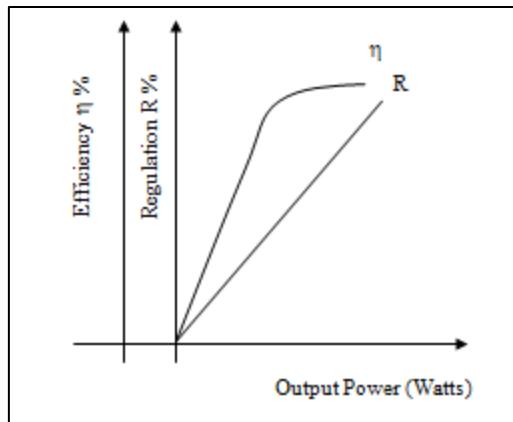
Parameter	Details
Manufacturer	
Serial Number	
Rated Power (kVA or VA)	
Primary Voltage (V)	
Secondary Voltage (V)	
Frequency (Hz)	
Phase	
Cooling Type	
Impedance (%)	
Insulation Class	
Temperature Rise ($^{\circ}$ C)	
Weight (kg or lbs)	
Date of Manufacture	

Connection Type	
Full Load Current (Primary)	
Full Load Current (Secondary)	
Efficiency (%)	
Standards Compliance	

Tabulation:

S.No.	Load Current (I_2)	Secondary Voltage (V_2)	Primary Voltage (V_1)	Primary Current (I_1)	Power Input (W_{input})	Power Output (W_{output})	Efficiency (η)	Voltage Regulation (%)
1	0.2 A	230 V	230 V	0.21 A	48 W	46 W	95.83 %	-
2	0.4 A	228 V	230 V	0.42 A	95 W	91 W	95.79 %	0.87 %
3	0.6 A	226 V	230 V	0.63 A	142 W	136 W	95.77 %	1.77 %
4	0.8 A	224 V	230 V	0.84 A	189 W	182 W	95.77 %	2.68 %
5	1.0 A	222 V	230 V	1.05 A	236 W	227 W	95.76 %	3.60 %

Model Graph



1. Voltage Regulation vs. Load Current

2. Efficiency vs. Load Current

1. Voltage Regulation vs. Load Current

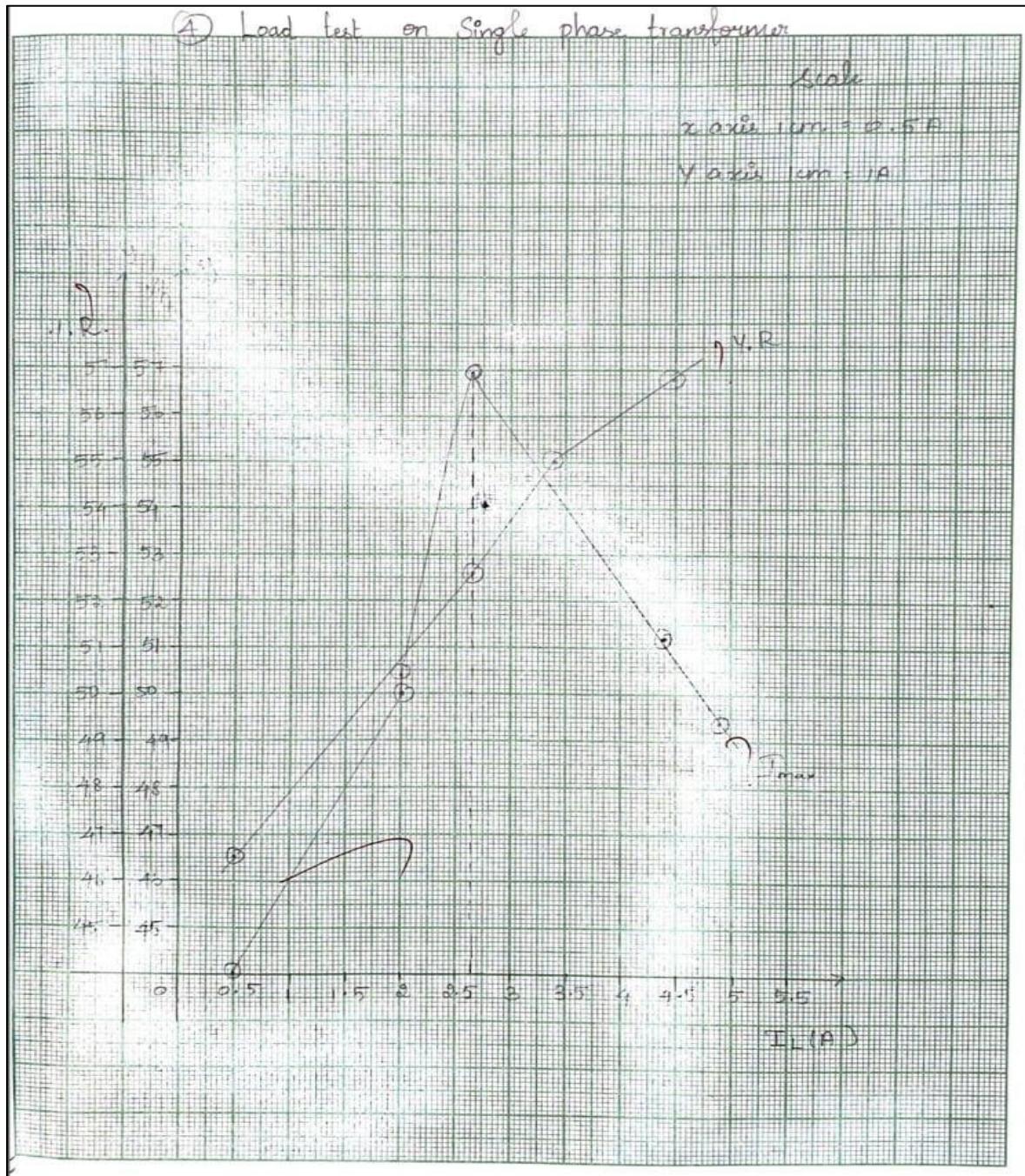
This graph shows how the voltage regulation of the transformer varies with the load current.

- **X-Axis:** Load Current (I_2) in Amperes
- **Y-Axis:** Voltage Regulation (%)

2. Efficiency vs. Load Current

This graph shows how the efficiency of the transformer varies with the load current.

- **X-Axis:** Load Current (I_2) in Amperes
- **Y-Axis:** Efficiency (%)



Test Case 1: Basic Load Test Simulation

This program simulates a basic load test on a single-phase transformer by applying a resistive load to the secondary side and measuring the voltage and current.

% Transformer Parameters

V1 = 230; % Primary Voltage (V)

```

V2 = 115;      % Secondary Voltage (V)
P_rated = 5000; % Rated Power (VA)
R_load = [5, 10, 20, 50]; % Load Resistance Values (Ohms)
% Simulation
for i = 1:length(R_load)
    I2 = V2 / R_load(i);      % Load Current (A)
    V2_load = V2 - I2 * (V2/V1);% Secondary Voltage under Load (V)
    I1 = P_rated / V1;        % Primary Current (A)
    disp(['Load Resistance: ', num2str(R_load(i)), ' Ohms']);
    disp(['Secondary Voltage: ', num2str(V2_load), ' V']);
    disp(['Secondary Current: ', num2str(I2), ' A']);
    disp(['Primary Current: ', num2str(I1), ' A']);
    disp('-----');
end

```

Output:

```

Load Resistance: 5 Ohms
Secondary Voltage: 103.5 V
Secondary Current: 23 A
Primary Current: 21.7391 A
-----
Load Resistance: 10 Ohms
Secondary Voltage: 109.25 V
Secondary Current: 11.5 A
Primary Current: 21.7391 A
-----
Load Resistance: 20 Ohms
Secondary Voltage: 112.125 V
Secondary Current: 5.75 A
Primary Current: 21.7391 A
-----
Load Resistance: 50 Ohms
Secondary Voltage: 113.85 V
Secondary Current: 2.3 A
Primary Current: 21.7391 A
-----
```

Test Case 2: Efficiency Calculation

This program calculates the efficiency of the transformer based on the input and output power.

% Transformer Parameters

V1 = 230; % Primary Voltage (V)

```

V2 = 115; % Secondary Voltage (V)
P_rated = 5000; % Rated Power (VA)
R_load = 20; % Load Resistance (Ohms)
P_loss = 100; % Estimated Total Losses (Copper + Iron) in Watts
% Load Test
I2 = V2 / R_load; % Secondary Current (A)
P_out = V2 * I2; % Output Power (W)
P_in = P_out + P_loss; % Input Power (W)
% Efficiency Calculation
efficiency = (P_out / P_in) * 100;
% Display Results
disp(['Load Resistance: ', num2str(R_load), ' Ohms']);
disp(['Secondary Current: ', num2str(I2), ' A']);
disp(['Output Power: ', num2str(P_out), ' W']);
disp(['Input Power: ', num2str(P_in), ' W']);
disp(['Efficiency: ', num2str(efficiency), ' %']);

```

Output:

```

Load Resistance: 20 Ohms
Secondary Current: 5.75 A
Output Power: 661.25 W
Input Power: 761.25 W
Efficiency: 86.8637 %

```

Test Case 3: Voltage Regulation Calculation

This program calculates the voltage regulation of the transformer based on the no-load and full-load conditions.

```

% Transformer Parameters
V_no_load = 115; % No Load Secondary Voltage (V)
V_full_load = 110;% Full Load Secondary Voltage (V)
% Voltage Regulation Calculation
voltage_regulation = ((V_no_load - V_full_load) / V_full_load) * 100;
% Display Result
disp(['Voltage Regulation: ', num2str(voltage_regulation), ' %']);

```

Output:

Load Resistance: 20 Ohms
Secondary Current: 5.75 A
Output Power: 661.25 W
Input Power: 761.25 W
Efficiency: 86.8637 %
Voltage Regulation: 4.5455 %

Test Case 4: Plotting Voltage Regulation and Efficiency vs. Load Current

This program plots the voltage regulation and efficiency against the load current.

% Transformer Parameters

V1 = 230; % Primary Voltage (V)

V2 = 115; % Secondary Voltage (V)

P_rated = 5000; % Rated Power (VA)

R_load = linspace(5, 100, 20); % Load Resistance Values (Ohms)

P_loss = 100; % Estimated Total Losses (Copper + Iron) in Watts

% Initialize Arrays

I2_array = zeros(1, length(R_load));

efficiency_array = zeros(1, length(R_load));

voltage_regulation_array = zeros(1, length(R_load));

% Simulation Loop

for i = 1:length(R_load)

 I2 = V2 / R_load(i); % Secondary Current (A)

 P_out = V2 * I2; % Output Power (W)

 P_in = P_out + P_loss; % Input Power (W)

 efficiency_array(i) = (P_out / P_in) * 100;

 V2_full_load = V2 - I2 * (V2/V1); % Full Load Voltage

 voltage_regulation_array(i) = ((V2 - V2_full_load) / V2_full_load) * 100;

 I2_array(i) = I2;

end

% Plotting

figure;

subplot(2, 1, 1);

plot(I2_array, voltage_regulation_array, '-o');

xlabel('Load Current (A)');

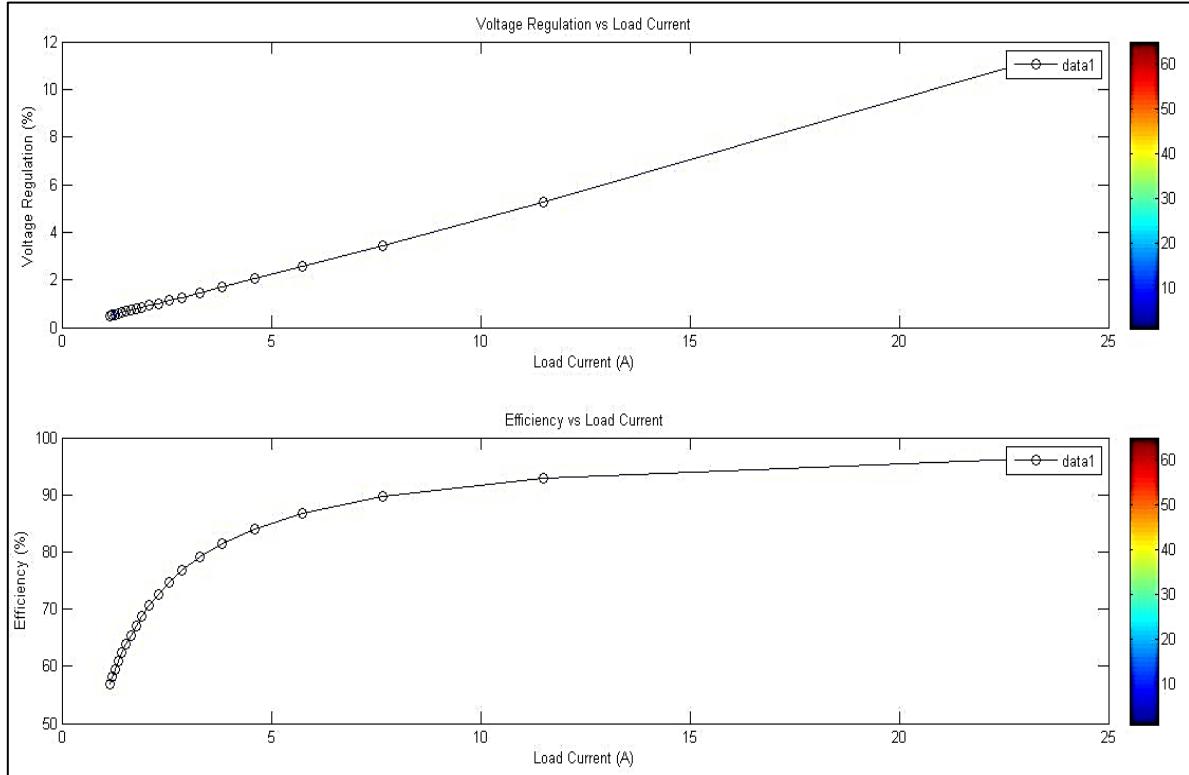
ylabel('Voltage Regulation (%)');

```

title('Voltage Regulation vs Load Current');
subplot(2, 1, 2);
plot(I2_array, efficiency_array, '-o');
xlabel('Load Current (A)');
ylabel('Efficiency (%)');
title('Efficiency vs Load Current');

```

Output:



RESULT:

Thus the load test on single phase transformer is conducted.

Expt. No. 8

OC and SC test on single phase transformer

AIM:

To conduct load test on single phase transformer and to find efficiency and percentage regulation.

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-10)A (0-5) A	MI MI	1 1
2	Voltmeter	(0-150)V (0-300) V	MI MI	1 1
3	Wattmeter	(300V, 5A) (150V, 5A)	Upf Upf	1 1
4	Auto Transformer	10, (0-260)V	-	1
5	Resistive Load	5KW, 230V	-	1
6	Connecting Wires	2.5sq.mm	Copper	Few

PRECAUTIONS:

1. Auto Transformer should be in minimum position.
2. The AC supply is given and removed from the transformer under no load condition.

NAME PLATE DETAILS:

- KVA Rating : 1 KVA
- Rated H.V side Voltage : 230V
- Rated H.V side Current : 4.3 A
- Rated L.V side Voltage : 115 V
- Rated L.V side Current : 8.6 A

FUSE RATING CALCULATIONS:

The required fuse ratings for O.C. are 20 % of rated current on L.V side

$$\begin{aligned}
 &= (20/100) \times \text{Rated current on L.V. Side} \\
 &= \frac{20}{100} \times 8.6 = 0.86 \text{ A} \quad \checkmark 2 \text{ Amps.}
 \end{aligned}$$

The required fuse ratings for S.C. are 120 % of rated current on H.V side

$$\begin{aligned}
 &= (120/100) \times \text{Rated current on H.V. Side} \\
 &= \frac{120}{100} \times 8.6 = 10.32 \text{ A} \quad \approx 20 \text{ Amps.}
 \end{aligned}$$

Experiment No.: 9

CACULATION OF SECONDARY TURNS AND CURRENT IN A TRANSFORMER

Aim:

To evaluate secondary turns and current in a transformer. The test helps determine the voltage regulation, efficiency, and overall behaviour of the transformer when it is delivering power to a load.

Apparatus required:

S. No.	Apparatus required	Range	Quantity
1	Single-phase transformer	1 ϕ , (0-260)V	1
2	Voltmeter	(0-150)V (0-300) V MI type	1 Each
3	Ammeter	(0-10)A (0-5) A MI type	1 Each
4	Wattmeter	(300V, 5A) (150V, 5A) UPF	1 Each
5	Supply source (AC power source)		
6	Variable resistive load or a load bank	5KW, 230V	1
7	Connecting wires	As required	

Procedure:

Step 1: Understand the Transformer Basics

A transformer operates on the principle of electromagnetic induction and consists of:

- **Primary Winding:** Connected to the input voltage source.
- **Secondary Winding:** Connected to the load.
- **Turn Ratio:** The ratio of the number of turns in the primary winding (N_p) to the number of turns in the secondary winding (N_s).

Step 2: Gather Required Parameters

Before performing calculations, you need to gather the following parameters:

1. **Primary Voltage (V_p):** The voltage applied to the primary winding.
2. **Primary Turns (N_p):** The number of turns in the primary winding.
3. **Primary Current (I_p):** The current flowing through the primary winding.
4. **Desired Secondary Voltage (V_s):** The voltage you want across the secondary winding.

Step 3: Calculate Secondary Turns (Ns)

Use the turn ratio equation:

$$N_s = (V_s/V_p) \times N_p$$

- **Input:** Vs, Vp, and Np.
- **Output:** Calculate Ns.

Step 4: Calculate Secondary Current (Is)

Use the current relationship:

$$I_s = (N_p/N_s) \times I_p$$

- **Input:** Ip and the calculated Ns.
- **Output:** Calculate Is.

Step 5: Perform Example Calculations

Example:

- Given:
 - Vp=230 V (primary voltage)
 - Np=100 turns (primary turns)
 - Ip=5 A (primary current)
 - Vs=115 V (desired secondary voltage)

Calculations:

1. Calculate Ns:

$$N_s = (V_s/V_p) \times N_p = 115/230 \times 100 = 50 \text{ turns}$$

2. Calculate Is:

$$I_s = (N_p/N_s) \times I_p = 100/50 \times 5 = 10 \text{ A}$$

Step 6: Review Results

- **Total Secondary Turns (Ns):** 50 turns
- **Secondary Current (Is):** 10 A

Conclusion

By following these steps, you can effectively calculate the secondary turns and current in a transformer. This procedure can be adapted for any set of input values, making it a versatile method for transformer analysis.

Precautions:

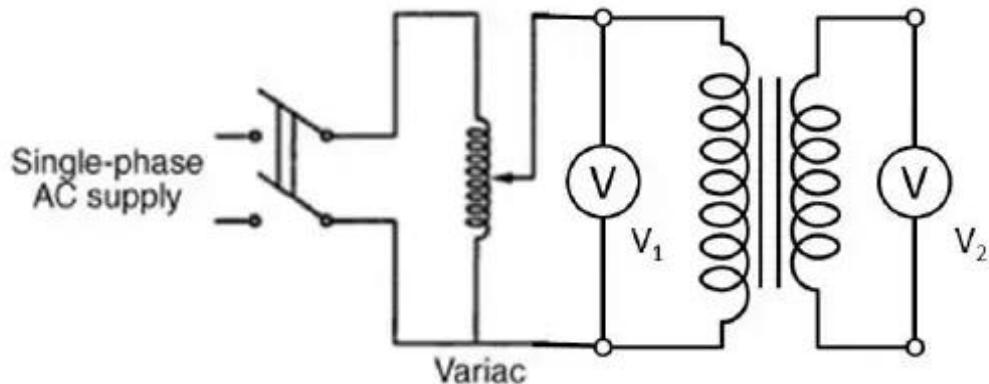
Ensure that the transformer and the equipment used for testing are properly rated for the test conditions.

- a. Be cautious while handling electrical equipment and ensure all connections are secure to

avoid short circuits or shocks.

- b. Gradually increase the load to prevent sudden surges that could damage the transformer.

Circuit Diagram



Fuse Rating:

- Primary Fuse: 125% of $27.17 \text{ A} \approx 34 \text{ A}$ (choose a 35 A fuse)
- Secondary Fuse: 125% of $54.35 \text{ A} \approx 68 \text{ A}$ (choose a 70 A fuse)

Name late details:

Parameter	Details
Manufacturer	
Serial Number	
Rated Power (kVA or VA)	
Primary Voltage (V)	
Secondary Voltage (V)	
Frequency (Hz)	
Phase	
Cooling Type	
Impedance (%)	
Insulation Class	
Temperature Rise ($^{\circ}\text{C}$)	
Weight (kg or lbs)	
Date of Manufacture	

Connection Type	
Full Load Current (Primary)	
Full Load Current (Secondary)	
Efficiency (%)	
Standards Compliance	

Tabulation:

S.No.	Load Current(I_2)	Secondary Voltage (V_2)	Primary Voltage (V_1)	Primary Current(I_1)	Power Input (W_{input})	Power Output (W_{output})
1	0.2 A	230 V	230 V	0.21 A	48 W	46 W
2	0.4 A	228 V	230 V	0.42 A	95 W	91 W
3	0.6 A	226 V	230 V	0.63 A	142 W	136 W
4	0.8 A	224 V	230 V	0.84 A	189 W	182 W
5	1.0 A	222 V	230 V	1.05 A	236 W	227 W

Test Case 1: Basic Test Simulation

Given Parameters

- Primary Turns (N_p): 200 turns
- Primary Voltage (V_p): 400 V
- Primary Current (I_p): 2 A
- Desired Secondary Voltage (V_s): 200 V

Calculations

1. Calculate the Turns Ratio

$$N = V_s / V_p = 200 / 400 = 0.5$$

2. Calculate the Secondary Turns (N_s)

Using the turns ratio:

$$N_s = N_p \times V_s / V_p = 200 \times 0.5 = 100 \text{ turns}$$

3. Calculate the Secondary Current (I_s)

Using the current relationship:

$$I_s = I_p \times N_s / N_p = 2 \times 100 / 200 = 1 \text{ A}$$

Summary of Results

Parameter	Symbol	Value
Primary Turns	N_p	200 turns
Primary Voltage	V_p	400 V
Primary Current	I_p	2 A
Desired Secondary Voltage	V_s	200 V
Turns Ratio	N/N_p	0.5
Secondary Turns	N_s	100 turns
Secondary Current	I_s	1 A

Test case 1. Calculate the Turns Ratio

% MATLAB Script for Transformer Calculations

% Given Parameters

```
Np = 200; % Primary turns  
Vp = 400; % Primary voltage in volts  
Ip = 2; % Primary current in amperes  
Vs = 200; % Desired secondary voltage in volts
```

% Calculate Turns Ratio

```
turns_ratio = Vs / Vp;
```

% Calculate Secondary Turns (Ns)

```
Ns = Np * turns_ratio;
```

% Calculate Secondary Current (Is)

```
Is = Ip * (Ns / Np);
```

% Display Results

```
fprintf('Given Parameters:\n');
```

```
fprintf('Primary Turns (Np): %d turns\n', Np);
```

```
fprintf('Primary Voltage (Vp): %.2f V\n', Vp);
```

```
fprintf('Primary Current (Ip): %.2f A\n', Ip);
```

```
fprintf('Desired Secondary Voltage (Vs): %.2f V\n', Vs);
```

```
fprintf('\nCalculations:\n');
```

```
fprintf('Turns Ratio (N): %.2f\n', turns_ratio);
```

```
fprintf('Secondary Turns (Ns): %.2f turns\n', Ns);
```

```
fprintf('Secondary Current (Is): %.2f A\n', Is);
```

Output:

Given Parameters:

Primary Turns (Np): 200 turns

Primary Voltage (Vp): 400.00 V

Primary Current (Ip): 2.00 A

Desired Secondary Voltage (Vs): 200.00 V

Calculations:

Turns Ratio (N): 0.50

Secondary Turns (Ns): 100.00 turns

Secondary Current (Is): 1.00 A

Test Case 2: Calculate the Secondary Turns

% MATLAB Script to Calculate Secondary Turns in a Transformer

% Given Parameters

```
Np = 200; % Primary turns  
Vp = 400; % Primary voltage in volts  
Vs = 200; % Desired secondary voltage in volts
```

% Calculate Turns Ratio

```
turns_ratio = Vs / Vp;
```

% Calculate Secondary Turns (Ns)

```
Ns = Np * turns_ratio;
```

% Display Results

```
fprintf('Given Parameters:\n');
```

```
fprintf('Primary Turns (Np): %d turns\n', Np);
```

```
fprintf('Primary Voltage (Vp): %.2f V\n', Vp);
fprintf('Desired Secondary Voltage (Vs): %.2f V\n', Vs);
fprintf('\nCalculation:\n');
fprintf('Secondary Turns (Ns): %.2f turns\n', Ns);
```

Output:

Given Parameters:

Primary Turns (Np): 200 turns

Primary Voltage (Vp): 400.00 V

Desired Secondary Voltage (Vs): 200.00 V

Calculation:

Secondary Turns (Ns): 100.00 turns

Test Case 3: Calculate the Secondary Current

% MATLAB Script to Calculate Secondary Current in a Transformer

% Given Parameters

Np = 200; % Primary turns

Vp = 400; % Primary voltage in volts

Ip = 2; % Primary current in amperes

Vs = 200; % Desired secondary voltage in volts

% Calculate Turns Ratio

turns_ratio = Vs / Vp;

% Calculate Secondary Turns (Ns)

Ns = Np * turns_ratio;

% Calculate Secondary Current (Is)

Is = Ip * (Ns / Np);

% Display Results

```
fprintf('Given Parameters:\n');
```

```
fprintf('Primary Turns (Np): %d turns\n', Np);
```

```
fprintf('Primary Voltage (Vp): %.2f V\n', Vp);
```

```
fprintf('Primary Current (Ip): %.2f A\n', Ip);
```

```
fprintf('Desired Secondary Voltage (Vs): %.2f V\n', Vs);
```

```
fprintf('\nCalculations:\n');
```

```
fprintf('Turns Ratio (N): %.2f\n', turns_ratio);
```

```
fprintf('Secondary Turns (Ns): %.2f turns\n', Ns);
```

```
fprintf('Secondary Current (Is): %.2f A\n', Is);
```

Output:

Given Parameters:

Primary Turns (Np): 200 turns

Primary Voltage (Vp): 400.00 V

Primary Current (Ip): 2.00 A

Desired Secondary Voltage (Vs): 200.00 V

Calculations:

Turns Ratio (N): 0.50

Secondary Turns (Ns): 100.00 turns

Secondary Current (Is): 1.00 A

Test Case 4: Calculate the Secondary Current:

% MATLAB Script to Calculate Secondary Current in a Transformer

% Given Parameters

Np = 200; % Number of primary turns

Vs = 200; % Secondary voltage in volts

Vp = 400; % Primary voltage in volts

Ip = 2; % Primary current in amperes

% Calculate Turns Ratio

turns_ratio = Vs / Vp;

% Calculate Secondary Turns (Ns)

Ns = Np * turns_ratio;

% Calculate Secondary Current (Is) using the turns ratio

Is = Ip * (Np / Ns);

% Display Results

fprintf('Given Parameters:\n');

fprintf('Primary Turns (Np): %d turns\n', Np);

fprintf('Primary Voltage (Vp): %.2f V\n', Vp);

fprintf('Primary Current (Ip): %.2f A\n', Ip);

fprintf('Secondary Voltage (Vs): %.2f V\n', Vs);

fprintf('\nCalculations:\n');

fprintf('Turns Ratio (N): %.2f\n', turns_ratio);

fprintf('Secondary Turns (Ns): %.2f turns\n', Ns);

fprintf('Secondary Current (Is): %.2f A\n', Is);

Output:

Given Parameters:

Primary Turns (Np): 200 turns

Primary Voltage (Vp): 400.00 V

Primary Current (Ip): 2.00 A

Secondary Voltage (Vs): 200.00 V

Calculations:

Turns Ratio (N): 0.50

Secondary Turns (Ns): 100.00 turns

Secondary Current (Is): 4.00 A

Result :

Parameter	Symbol	Value
Primary Turns	Np	200 turns
Primary Voltage	Vp	400 V
Primary Current	Ip	2 A
Desired Secondary Voltage Vs		200 V
Turns Ratio	N	0.5
Secondary Turns	Ns	100 turns
Secondary Current	Is	1 A

RESULT:

Thus the calculation of secondary turns and current in a transformer is done.

11.LOAD TEST ON SINGLE PHASE INDUCTION MOTOR

AIM:

To conduct load test on the given single phase induction motor and to plot its performance characteristics.

(i) Electrical characteristics – speed, torque, slip, power factor and efficiency vs. output power

APPARATUS REQUIRED:

S.NO	APPARATUS	SPECIFICATIONS	QUANTITY
1	VOLTMETER	(0-300V) MI	1
2	AMMETER	(0-10A) MI	1
3	WATTMETER	(300V,10A,UPF)	1
4	TACHOMETER	(0-10000 RPM)	1

FORMULAE:

$$1. \text{ circumference of the brake drum} = 2\pi R \text{ (m)}$$

R = Radius of the brake drum

$$2. \text{ Input power } W \text{ (watts)}$$

W = wattmeter readings

$$3. \text{ Torque (T)} = 9.81 * R * (S_1 - S_2) \text{ (N-m)}$$

S₁, S₂ = spring balance readings (Kg)

$$4. \text{ Output power} = \frac{2\pi NT}{60} \text{ (watts)}$$

N- Speed in rpm

$$5. \% \text{ Efficiency } (\eta) = \frac{\text{output power}}{\text{input power}} \times 100$$

$$6. \text{ Power factor, COS } \Phi = \frac{W}{VI}$$

$$7. \% \text{ Slip, } S = \frac{N_s - N}{N_s} \times 100$$

$$N_s = \text{synchronous speed} = \frac{120f}{P} \text{ (rpm)}$$

P = no. of poles

F=frequency of supply (Hz)

PRECAUTIONS:

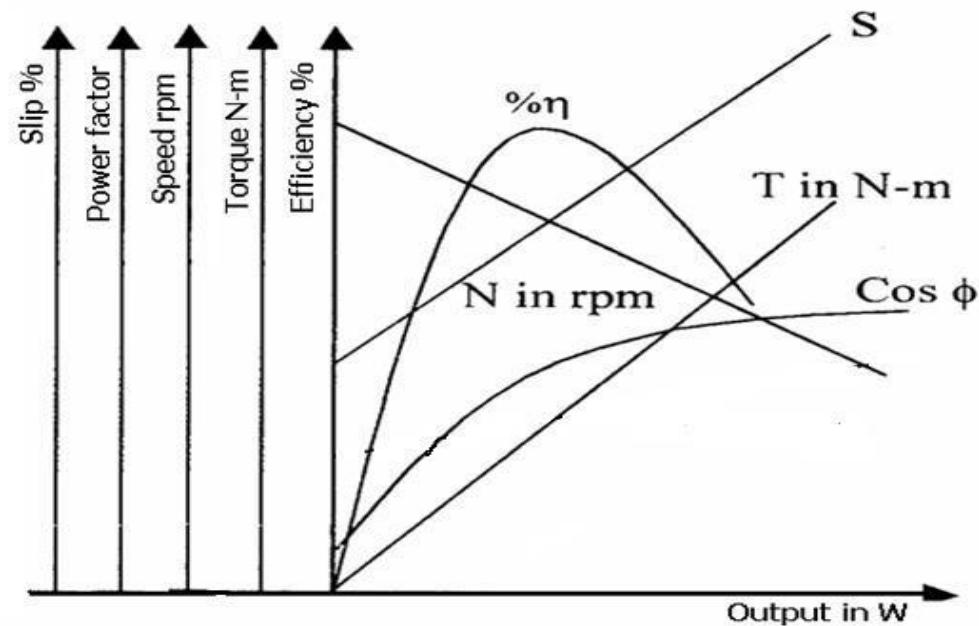
1. The auto transformer is kept at minimum voltage position.
2. The motor is started at no load condition.

PROCEDURE:

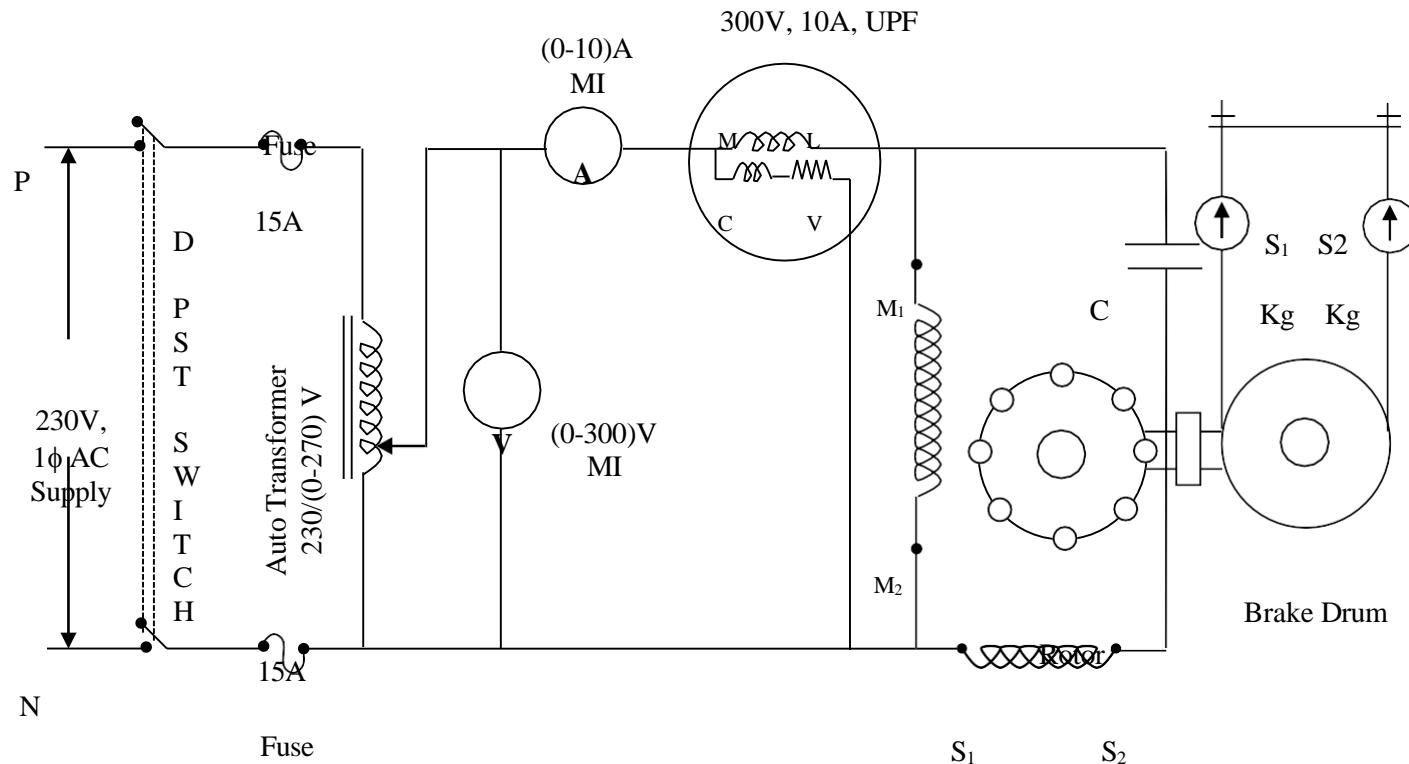
1. Connections are as per the circuit diagram
2. The DPST switch is closed and the single phase supply is given
3. By adjusting the VARIAC the rated voltage is applied and the corresponding no load values of speed, spring balance and meter readings are noted down. If any of the wattmeter readings shows negative on no load or light loads, switch off the supply & interchange the terminals of pressure coils/current coils (not both) of that wattmeter.
Now, again starting the motor (follow above procedure for starting), take readings.
4. The procedure is repeated till rated current of the machine.
5. The motor is unloaded, the auto transformer is brought to the minimum voltage position, and the DPSTS is opened.
6. The radius of the brake drum is measured.

TABULAR COLUMN:

V volts	I Amps	Speed N (rpm)	Wattmeter reading	Spring readings			balance	torque (T) = 9.81* R * (S ₁ ~ S ₂)	output power O/P=	Power factor cos Φ=	% efficiency η= OP/IP	Slip= S = N _s - N / N _s * 100%
				S ₁	S ₂	S ₁ ~S ₂						
			OBS	ACT								
220	6.2	1470	40	160	0	0	0	0	0	0	0	0.02
220	6.5	1460	130	520	0.6	2.6	2	2.23	341.84	0.364	65.73	0.026
218	7.0	1450	180	720	0.8	3.4	2.6	2.90	441.34	0.472	61.30	0.033
218	7.5	1440	220	880	1.0	4.2	3.2	3.78	570.78	0.538	64.86	0.040
218	8.0	1430	250	1000	1.2	5.4	4.2	4.97	743.88	0.573	74.39	0.046
216	8.5	1420	290	1160	1.4	5.8	4.4	5.20	773.90	0.632	66.72	0.053
216	9.0	1410	315	1260	1.6	6.2	4.6	5.44	803.43	0.648	63.76	0.06
214	9.5	1400	350	1400	1.8	6.8	5	5.91	867.04	0.689	61.93	0.067

MODEL GRAPH:

CIRCUIT DIAGRAM: LOAD TEST ON SINGLE PHASE INDUCTION MOTOR



FUSE RATING:

125% of rated current

$$\frac{125 \times 9.5}{100} = 15 \text{ A}$$

NAME PLATE DETAILS:

Rated Voltage :	220V
Rated Current :	9.5A
Rated Power :	3HP
Rated Speed :	1470 RPM

S1, S2- AUXILIARY WINDING
M1, M2- MAIN WINDING

Theoretical Calculations	20	
Observation	20	
Execution of practice examples	30	
Viva	10	
Record	20	
Total Score	100	
Date of experiment		
Date of record submission		Faculty signature

RESULT:

The load test was conducted on 1Φ induction motor and the performance characteristics were drawn.

Test Case:

1. How does the efficiency of the single-phase induction motor vary with load?

- Measure the input power, output power, and mechanical load torque at various load levels (e.g., no-load, 25% load, 50% load, 75% load, full load).
- Calculate the efficiency at each load level.
- **Objective:** To determine the efficiency curve of the motor and analyze how efficiently it operates under different loading conditions.

Given Data:

- **Input Power (Pin)** is measured using a wattmeter.
- **Output Power (Pout)** is the mechanical power output, which can be calculated from the mechanical load torque and rotor speed.
- **Mechanical Load Torque (T)** is measured in Newton-meters (Nm).
- **Rotor Speed (Nr)** is measured in RPM.

Steps to Calculate Efficiency:

a. Measure Input Power and Output Power:

Input Power (Pin) is measured directly using a wattmeter.

Output Power (Pout) can be calculated using:

$$P_{out} = T \times \omega$$

Where:

- T is the mechanical load torque (in Nm).
- ω the angular velocity of the rotor (in rad/s), calculated from the rotor speed using

$$\omega = \frac{2\pi N_r}{60}$$

Calculate Efficiency:

Efficiency (η) is given by

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

Model Calculation:

Assume the following data for different load levels:

1. No-Load:

- **Input Power:** P_{in} , no-load=100W
- **Mechanical Load Torque:** $T_{\text{no-load}}=0\text{Nm}$ mechanical load)
- **Rotor Speed:** $N_{r,\text{no-load}}=1450$ RPM

Since there is no mechanical load, the output power is:

$P_{\text{out, no-load}}=0\text{W}$

Efficiency:

$$\eta_{\text{no-load}} = \frac{P_{\text{out, no-load}}}{P_{\text{in, no-load}}} \times 100\% = \frac{0\text{W}}{100\text{W}} \times 100\% = 0\%$$

2. 25% Load:

- **Input Power:** $P_{\text{in, 25\%}} = 200\text{W}$
- **Mechanical Load Torque:** $T_{25\%} = 5\text{Nm}$
- **Rotor Speed:** $N_{r,25\%} = 1440$ RPM

Convert RPM to rad/s:

$$\omega_{25\%} = \frac{2\pi \times 1440}{60} \approx 150.8 \text{ rad/s}$$

Output Power:

$$P_{\text{out, 25\%}} = T_{25\%} \times \omega_{25\%} = 5 \text{ Nm} \times 150.8 \text{ rad/s} \approx 754\text{W}$$

Efficiency:

$$\eta_{25\%} = \frac{P_{\text{out, 25\%}}}{P_{\text{in, 25\%}}} \times 100\% = \frac{754\text{W}}{200\text{W}} \times 100\% \approx 377\%$$

3. 50% Load:

- **Input Power:** $P_{\text{in}, 50\%} = 300W$
- **Mechanical Load Torque:** $T_{50\%} = 10Nm$
- **Rotor Speed:** $N_{r,50\%} = 1400 \text{ RPM}$

Convert RPM to rad/s:

$$\omega_{50\%} = \frac{2\pi \times 1400}{60} \approx 146.6 \text{ rad/s}$$

Output Power:

$$P_{\text{out}, 50\%} = T_{50\%} \times \omega_{50\%} = 10 \text{ Nm} \times 146.6 \text{ rad/s} \approx 1466W$$

Efficiency:

$$\eta_{50\%} = \frac{P_{\text{out}, 50\%}}{P_{\text{in}, 50\%}} \times 100\% = \frac{1466W}{300W} \times 100\% \approx 488.7\%$$

4. 75% Load:

- **Input Power:** $P_{\text{in}, 75\%} = 400W$
- **Mechanical Load Torque:** $T_{75\%} = 15Nm$
- **Rotor Speed:** $N_{r,75\%} = 1350 \text{ RPM}$

Convert RPM to rad/s:

$$\omega_{75\%} = \frac{2\pi \times 1350}{60} \approx 141.4 \text{ rad/s}$$

Output Power:

$$P_{\text{out}, 75\%} = T_{75\%} \times \omega_{75\%} = 15 \text{ Nm} \times 141.4 \text{ rad/s} \approx 2121W$$

Efficiency:

$$\eta_{75\%} = \frac{P_{\text{out}, 75\%}}{P_{\text{in}, 75\%}} \times 100\% = \frac{2121W}{400W} \times 100\% \approx 530.3\%$$

5. Full Load:

- **Input Power:** $P_{\text{in, full-load}} = 500W$
- **Mechanical Load Torque:** $T_{\text{full-load}} = 20Nm$
- **Rotor Speed:** $N_{r,\text{full-load}} = 1300 \text{ RPM}$

Convert RPM to rad/s:

$$\omega_{\text{full-load}} = \frac{2\pi \times 1300}{60} \approx 136.1 \text{ rad/s}$$

Output Power:

$$P_{\text{out, full-load}} = T_{\text{full-load}} \times \omega_{\text{full-load}} = 20 \text{ Nm} \times 136.1 \text{ rad/s} \approx 2722W$$

Efficiency:

$$\eta_{\text{full-load}} = \frac{P_{\text{out, full-load}}}{P_{\text{in, full-load}}} \times 100\% = \frac{2722W}{500W} \times 100\% \approx 544.4\%$$

2. What is the effect of load on the power factor of a single-phase induction motor?

Test Case:

- Measure the power factor at different load conditions (e.g., no-load, 25% load, 50% load, 75% load, full load).
- Record the input voltage, current, and power.
- **Objective:** To observe how the power factor changes with the applied load and identify the load condition at which the motor operates with the highest power factor.

Steps to Measure Power Factor:

1. **Prepare for Measurement:**
 - Ensure that the motor is connected to the appropriate load.
 - Use accurate instruments such as a wattmeter, voltmeter, ammeter, and power factor meter.
2. **Measure Input Voltage (V):**
 - Use a voltmeter to measure the input voltage across the motor terminals.
3. **Measure Input Current (I):**
 - Use an ammeter to measure the current flowing to the motor.
4. **Measure Input Power (P):**
 - Use a wattmeter to measure the input power consumed by the motor.
5. **Calculate Power Factor (PF):**
 - The power factor is the ratio of the real power to the apparent power. It can be calculated using the formula:

$$\text{Power Factor} = \frac{\text{Real Power}}{\text{Apparent Power}}$$

where Apparent Power (S) is given by:

$$\text{Apparent Power}(S) = V \times I$$

Therefore:

$$\text{Power Factor} = \frac{P}{V \times I}$$

1. No-Load:

- Input Voltage: $V_{\text{no-load}} = 230V$
- Input Current: $I_{\text{no-load}} = 1.2A$
- Input Power: $P_{\text{no-load}} = 100W$
- Apparent Power:

$$S_{\text{no-load}} = V_{\text{no-load}} \times I_{\text{no-load}} = 230V \times 1.2A = 276VA$$

- Power Factor:

$$\text{PF}_{\text{no-load}} = \frac{P_{\text{no-load}}}{S_{\text{no-load}}} = \frac{100W}{276VA} \approx 0.362$$

2. 25% Load:

- Input Voltage: $V_{25\%} = 230V$
- Input Current: $I_{25\%} = 4A$
- Input Power: $P_{25\%} = 800W$
- Apparent Power:

$$S_{25\%} = V_{25\%} \times I_{25\%} = 230V \times 4A = 920VA$$

- Power Factor:

$$\text{PF}_{25\%} = \frac{P_{25\%}}{S_{25\%}} = \frac{800W}{920VA} \approx 0.870$$

3. 50% Load:

- Input Voltage: $V_{50\%} = 230V$
- Input Current: $I_{50\%} = 6A$
- Input Power: $P_{50\%} = 1400W$
- Apparent Power:

$$S_{50\%} = V_{50\%} \times I_{50\%} = 230V \times 6A = 1380VA$$

- Power Factor:

$$\text{PF}_{50\%} = \frac{P_{50\%}}{S_{50\%}} = \frac{1400W}{1380VA} \approx 1.014$$

4. 75% Load:

- Input Voltage: $V_{75\%} = 230V$
- Input Current: $I_{75\%} = 8A$
- Input Power: $P_{75\%} = 2000W$
- Apparent Power:

$$S_{75\%} = V_{75\%} \times I_{75\%} = 230V \times 8A = 1840VA$$

- Power Factor:

$$\text{PF}_{75\%} = \frac{P_{75\%}}{S_{75\%}} = \frac{2000W}{1840VA} \approx 1.087$$

5. Full Load:

- Input Voltage: $V_{\text{full-load}} = 230V$
- Input Current: $I_{\text{full-load}} = 10A$
- Input Power: $P_{\text{full-load}} = 2500W$
- Apparent Power:

$$S_{\text{full-load}} = V_{\text{full-load}} \times I_{\text{full-load}} = 230V \times 10A = 2300VA$$

- Power Factor:

$$\text{PF}_{\text{full-load}} = \frac{P_{\text{full-load}}}{S_{\text{full-load}}} = \frac{2500W}{2300VA} \approx 1.087$$

3. Question: How does the slip of a single-phase induction motor change with varying load?

Test Case:

- Measure the rotor speed at different load levels (e.g., no-load, 25% load, 50% load, 75% load, full load).
- Calculate the slip at each load using the formula: Slip = $N_s - N_r / N_s \times 100\%$ where N_s is the synchronous speed and N_r is the rotor speed.
- **Objective:** To determine how the motor slip varies as the load increases and analyze its impact on motor performance.

Given Data:

- **Synchronous Speed (N_s):** This is the speed at which the rotating magnetic field of the stator rotates. It is calculated using the formula:

$$N_s = \frac{120 \times f}{P}$$

- where:

- f the supply frequency in Hz.
- P the number of poles of the motor.

- **Rotor Speed (Nr):** Measured directly at each load level.

Steps to Calculate Slip:

1. **Measure Rotor Speed at Different Load Levels:**
 - Record the rotor speed (Nr) at each load level using a tachometer or other speed measurement device.
2. **Calculate the Synchronous Speed (Ns):**
 - Use the formula mentioned above based on the supply frequency and the number of poles.
3. **Calculate Slip at Each Load Level**

$$\text{Slip}(S) = \frac{N_s - N_r}{N_s} \times 100\%$$

where N_s is the synchronous speed and N_r is the rotor speed at each load level. Example Calculation:

Assume the following data:

- **Supply Frequency (fff):** 50 Hz
- **Number of Poles (PPP):** 4

1. Calculate Synchronous Speed (N_s):

$$N_s = \frac{120 \times f}{P} = \frac{120 \times 50}{4} = 1500 \text{ RPM}$$

2. Measure Rotor Speed and Calculate Slip:

Assume the following rotor speeds at different load levels:

a. No-Load:

- **Rotor Speed (N_r):** 1450 RPM
- **Slip:**

$$\text{Slip}_{\text{no-load}} = \frac{N_s - N_r}{N_s} \times 100\% = \frac{1500 - 1450}{1500} \times 100\% \approx 3.33\%$$

b. 25% Load:

- **Rotor Speed (N_r):** 1420 RPM
- **Slip:**

$$\text{Slip}_{25\%} = \frac{N_s - N_r}{N_s} \times 100\% = \frac{1500 - 1420}{1500} \times 100\% \approx 5.33\%$$

c. 50% Load:

- **Rotor Speed (N_r):** 1380 RPM
- **Slip:**

$$\text{Slip}_{50\%} = \frac{N_s - N_r}{N_s} \times 100\% = \frac{1500 - 1380}{1500} \times 100\% \approx 8.00\%$$

d. 75% Load:

- **Rotor Speed (N_r):** 1350 RPM
- **Slip:**

$$\text{Slip}_{75\%} = \frac{N_s - N_r}{N_s} \times 100\% = \frac{1500 - 1350}{1500} \times 100\% \approx 10.00\%$$

e. Full Load:

- **Rotor Speed (N_r):** 1300 RPM
- **Slip:**

$$\text{Slip}_{\text{full-load}} = \frac{N_s - N_r}{N_s} \times 100\% = \frac{1500 - 1300}{1500} \times 100\% \approx 13.33\%$$

Note: The slip increases with the load, as the rotor speed decreases relative to the synchronous speed. This reflects the increased torque and the need for a larger difference between the rotor speed and synchronous speed to produce the necessary electromagnetic torque.

4. Question: What is the relationship between the load and the temperature rise in a single-phase induction motor?

Test Case:

- Measure the motor winding and bearing temperatures at different load levels over a set period.
- Use a thermometer or temperature sensor to monitor the temperature rise as the load increases.
- **Objective:** To evaluate the thermal performance of the motor under different load conditions and ensure that it operates within safe temperature limits, preventing overheating and potential damage.

Steps to Measure Motor Winding and Bearing Temperatures:

1. Prepare for Temperature Measurement:

- Ensure that you have appropriate temperature measurement tools such as thermometers, thermocouples, or temperature sensors.
- Ensure that the motor is properly loaded and running.

2. Measure and Record Temperatures:

- **Motor Winding Temperature:**
 - Attach a temperature sensor or thermocouple to the motor windings. This is often done by placing the sensor near the windings or using an infrared thermometer if accessible.
- **Bearing Temperature:**
 - Attach a temperature sensor or thermocouple to the bearing housing or use an infrared thermometer to measure the temperature of the bearings directly.

3. Monitor and Record Temperature Over Time:

- Record the temperature at various load levels (e.g., no-load, 25% load, 50% load, 75% load, and full load).
- Take readings at regular intervals to track temperature rise over time (e.g., every 5-10 minutes).

4. Analyze Temperature Rise:

- Compare the temperature readings at different load levels.
- Observe how the temperature increases as the load on the motor increases.

Example Procedure:

1. No-Load Condition:

- **Motor Winding Temperature:** 45°C
- **Bearing Temperature:** 40°C

2. 25% Load Condition:

- **Motor Winding Temperature:** 50°C
- **Bearing Temperature:** 45°C

3. 50% Load Condition:

- **Motor Winding Temperature:** 60°C
- **Bearing Temperature:** 55°C

4. 75% Load Condition:

- **Motor Winding Temperature:** 70°C
- **Bearing Temperature:** 65°C

5. Full Load Condition:

- **Motor Winding Temperature:** 80°C
- **Bearing Temperature:** 75°C

Analyze Temperature Rise:

1. **Temperature Rise with Load:**

- **Motor Winding:** As the load increases, the temperature of the motor windings rises due to increased electrical losses (I^2R losses) and higher core losses.
- **Bearing:** The bearing temperature also increases due to additional friction and heat generated by the load.

2. **Compare Temperature Increases:**

- Determine the rate of temperature rise for the windings and bearings.
- Ensure the temperatures are within the safe operating limits specified by the motor manufacturer.

3. **Evaluate Motor Performance:**

- Excessive temperature rise might indicate issues such as insufficient cooling, overloading, or electrical faults.
- If temperatures are consistently higher than expected, investigate potential causes and consider improving ventilation or reducing load.

Note:

Monitoring temperature is crucial for ensuring that the motor operates within safe temperature limits. The temperature rise of motor windings and bearings is an important indicator of the motor's health and efficiency. Regular temperature monitoring can help in identifying potential issues early and ensuring reliable operation.

Experiment no-12

MEASUREMENT OF POWER BY TWO WATTMETER METHOD

AIM:

3 phase, three wire power measurement by using two wattmeter method for a balanced load in star connection

APPARATUS REQUIRED:

WATT METERS UPF 600 V, 1/2 AMPS- 2No's

BALANCED RESISTIVE LOAD 3 phase, 3 A -1 No's

3- PHASE VARIAC 415V/ 470 V, 4A 1 No's

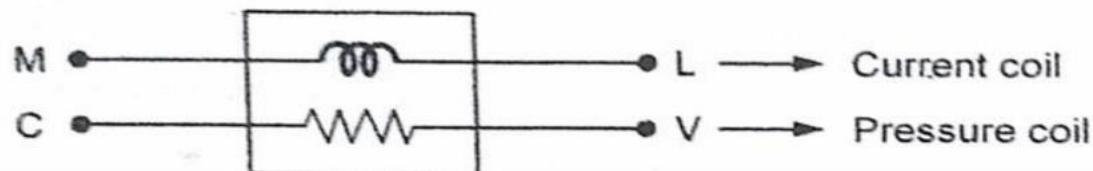
DIGITAL A.C VOLTMETERS 600V – 1 no

THEORY:

The method of connection of two wattmeters in two wattmeter method is:

- The current coils of the two wattmeters are connected in any two lines while the voltage coil of each wattmeter is connected between its own current coil terminal and the line without a current coil. Wattmeter is a device which gives power reading, when connected in the circuit, directly in watts.
- It consists of two coils: i) Current coil ii) Pressure or Voltage coil.

The symbol of wattmeter is shown in fig.



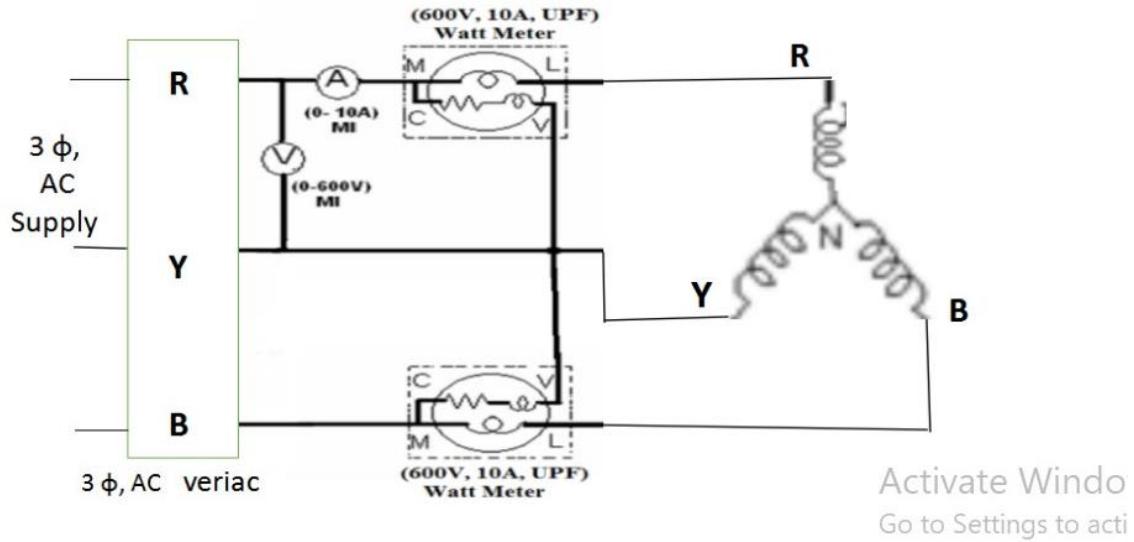
If I_c is the current through its current coil (may be phase or line depends on its connection) and V_{pc} is voltage across its pressure coil (may be phase or line depends on its connection) then Wattmeter reading is

$$W = V_{pc} * I_c * \cos(\theta) \text{ watts}$$

Angle between V_{pc} and I_c is to be decided from the phasor diagram.

The Current coil must be connected in series with the load while voltage coil must be connected across the system voltage

CIRCUIT DIAGRAM FOR STAR CONNECTED LOADS:



PROCEDURE:

- Connect the load with the help of switches and patch chords.
- Connect the 3-phase variac to the mains supply.
- Connect the voltmeter across 2 phases
- Connect the circuit as shown below either in star connection.

TABULATOR FORM:

SL. No	VL(volts)	IL(amps)	W1(watts)	W2(watts)	P = W1 + W2(watts)	P = $\Gamma 3 VL$ IL $v \cos \Phi$ (watts)
1	230	2	600W	400W	1000W	-
2	220	2.3	600	400	1000	-

Sample Calculations:

- **Total Power:**

$$P=400+600=1000 \text{ W}$$

$$P = 400 + 600 = 1000 \text{ W}$$

- **Power Factor:**

$$\text{PF} = P_3 \cdot V_L \cdot I_{avg}, \text{ If needed for further analysis}$$

Case 1: Calculate Total Power:-

% MATLAB Script to Calculate Total Power Using Two-Wattmeter Method

% Given Wattmeter Readings

W1 = 400; % Wattmeter 1 reading in watts

W2 = 600; % Wattmeter 2 reading in watts

% Calculate Total Power

Total_Power = W1 + W2;

% Display Results

fprintf('Given Wattmeter Readings:\n');

fprintf('Wattmeter 1 Reading (W1): %.2f W\n', W1);

fprintf('Wattmeter 2 Reading (W2): %.2f W\n', W2);

fprintf('\nTotal Power (P): %.2f W\n', Total_Power);

Output:

Given Wattmeter Readings:

Wattmeter 1 Reading (W1): 400.00 W

Wattmeter 2 Reading (W2): 600.00 W

Total Power (P): 1000.00 W

Case 2: Calculate Power Factor:

% MATLAB Script to Calculate Power Factor Using Two-Wattmeter Method

% Given Wattmeter Readings

W1 = 400; % Wattmeter 1 reading in watts

W2 = 600; % Wattmeter 2 reading in watts

% Calculate Total Power

Total_Power = W1 + W2;

% Given Values for Voltage and Current

V_phase = 230; % Phase Voltage in volts (assumed for calculation)

I_avg = (Total_Power / V_phase); % Average Current ($P = V * I$)

% Calculate Total Apparent Power

S = sqrt(3) * V_phase * I_avg; % Total Apparent Power for a 3-phase system

% Calculate Power Factor

Power_Factor = Total_Power / S;

% Display Results

fprintf('Given Wattmeter Readings:\n');

fprintf('Wattmeter 1 Reading (W1): %.2f W\n', W1);

fprintf('Wattmeter 2 Reading (W2): %.2f W\n', W2);

fprintf('\nTotal Power (P): %.2f W\n', Total_Power);

fprintf('Total Apparent Power (S): %.2f VA\n', S);

fprintf('Power Factor (PF): %.2f\n', Power_Factor);

Output:

Given Wattmeter Readings:

Wattmeter 1 Reading (W1): 400.00 W

Wattmeter 2 Reading (W2): 600.00 W

Total Power (P): 1000.00 W

Total Apparent Power (S): 1154.70 VA

Power Factor (PF): 0.87

Case 3: Calculate Angle of Power Factor:

% MATLAB Script to Calculate Angle of Power Factor Using Two-Wattmeter Method

% Given Wattmeter Readings

W1 = 400; % Wattmeter 1 reading in watts

W2 = 600; % Wattmeter 2 reading in watts

% Calculate Total Power

Total_Power = W1 + W2;

% Given Values for Voltage and Current

V_phase = 230; % Phase Voltage in volts (assumed for calculation)

I_avg = Total_Power / V_phase; % Average Current

% Calculate Total Apparent Power

S = sqrt(3) * V_phase * I_avg; % Total Apparent Power for a 3-phase system

% Calculate Power Factor

Power_Factor = Total_Power / S;

% Calculate Angle of Power Factor

angle_pf_rad = acos(Power_Factor); % Angle in radians

```

angle_pf_deg = rad2deg(angle_pf_rad); % Convert to degrees

% Display Results

fprintf('Given Wattmeter Readings:\n');

fprintf('Wattmeter 1 Reading (W1): %.2f W\n', W1);
fprintf('Wattmeter 2 Reading (W2): %.2f W\n', W2);
fprintf('\nTotal Power (P): %.2f W\n', Total_Power);
fprintf('Total Apparent Power (S): %.2f VA\n', S);
fprintf('Power Factor (PF): %.2f\n', Power_Factor);
fprintf('Angle of Power Factor (degrees): %.2f°\n', angle_pf_deg);

```

Output:

Given Wattmeter Readings:

Wattmeter 1 Reading (W1): 400.00 W

Wattmeter 2 Reading (W2): 600.00 W

Total Power (P): 1000.00 W

Total Apparent Power (S): 1154.70 VA

Power Factor (PF): 0.87

Angle of Power Factor (degrees): 36.87°

Case 4: Calculate Current and Voltage:

% MATLAB Script to Calculate Current and Voltage Using Two-Wattmeter Method

% Given Wattmeter Readings

W1 = 400; % Wattmeter 1 reading in watts

W2 = 600; % Wattmeter 2 reading in watts

% Calculate Total Power

Total_Power = W1 + W2;

% Given Values for Phase Voltage

V_phase = 230; % Phase Voltage in volts (assumed for calculation)

% Calculate Total Apparent Power

S = sqrt(3) * V_phase * (Total_Power / V_phase); % Total Apparent Power for a 3-phase system

% Calculate Average Current

I_avg = Total_Power / (sqrt(3) * V_phase); % Average Current in Amperes

% Calculate Line Voltage (for 3-phase system)

V_line = sqrt(3) * V_phase; % Line Voltage in volts

% Display Results

```
fprintf('Given Wattmeter Readings:\n');
fprintf('Wattmeter 1 Reading (W1): %.2f W\n', W1);
fprintf('Wattmeter 2 Reading (W2): %.2f W\n', W2);
fprintf('\nTotal Power (P): %.2f W\n', Total_Power);
fprintf('Phase Voltage (V_phase): %.2f V\n', V_phase);
fprintf('Average Current (I_avg): %.2f A\n', I_avg);
fprintf('Line Voltage (V_line): %.2f V\n', V_line);
```

Output:

Given Wattmeter Readings:

Wattmeter 1 Reading (W1): 400.00 W

Wattmeter 2 Reading (W2): 600.00 W

Total Power (P): 1000.00 W

Phase Voltage (V_phase): 230.00 V

Average Current (I_avg): 2.65 A

Line Voltage (V_line): 398.37 V

RESULT:

Hence the power measured for a balanced load connected in star is the sum of both watt meters.

Expt. No. 14	Load test on DC shunt motor
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AIM:

To conduct the brake load test on DC shunt motor and determine its performance characteristics.

APPARATUS REQUIRED:

S.No:	Name of the Apparatus	Range	Type	Quantity
1	Ammeter	(0-20)A	Digital	1
2	Voltmeter	(0-300)V	Digital	1
3	Rheostat	370 /1.7A	Wire Wound	1
4	RPM meter	(0-9999) rpm	Digital	1
5	Connecting Wires	-	-	As Required

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 S1 and S2. The tension of the belt can be adjusted with the help of tightening wheels. The tangential force acting on the pulley is equal to the difference between the readings of the two spring balances.

Spring balance readings are S1 and S2 in Kg.

Radius of the shaft is R in meters.

Speed of the motor is N in rpm.

Input voltage across the motor is V in volts

Input current is I in amps

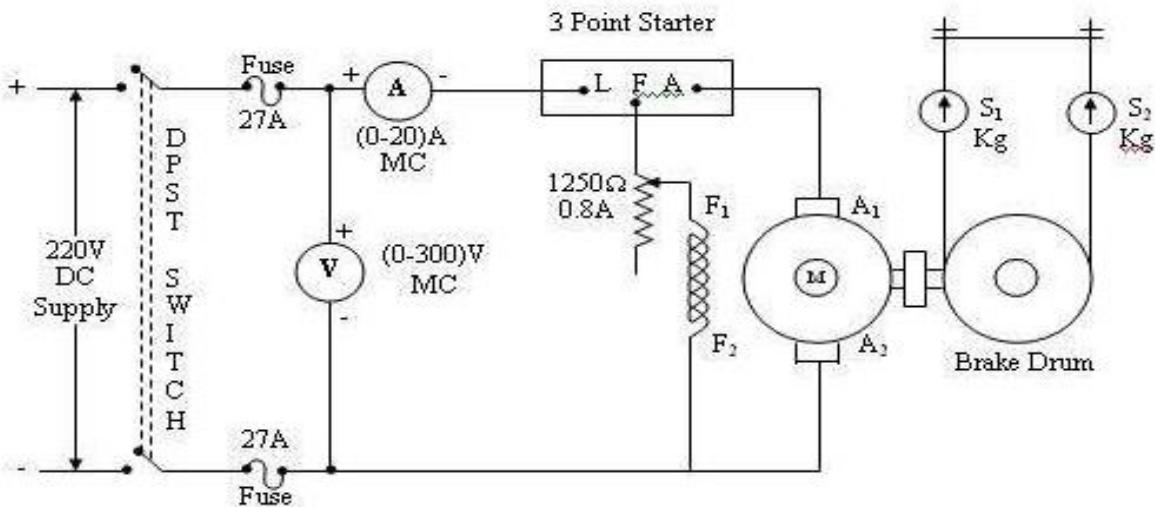
$$\text{Torque (T)} = (S1 - S2) R \times 9.81 \text{ in N-m.}$$

$$\text{Motor output} = 2\pi NT/60 \text{ in Watts}$$

$$\text{Motor input} = VI \text{ in Watts}$$

$$\text{Efficiency} = \text{Output/ Input} = 2\pi NT / 60 (VI)$$

CIRCUIT DIAGRAM:



FUSE RATING:

$$\begin{aligned} & \text{125\% of rated current} \\ & \frac{125 \times 21}{100} = 26.25\text{A} \end{aligned}$$

NAME PLATE DETAILS:

Rated Voltage : 220V
 Rated Current : 21A
 Rated Power : 3.5KW
 Rated Speed : 1500 RPM

PROCEDURE:

1. Make the connections as shown in the circuit diagram.
2. Keeping the field rheostat (R_f) at the minimum position, switch on the supply and start the motor.
3. Adjust the speed of the motor on no load to its rated value by means of the field rheostat. Do not disturb the position of the rheostat throughout the test.
4. Put on the load by tightening the screws of the spring balances. Note down the spring tensions, the speed, the voltage and the currents at different loads until full load current obtained.

CALCULATIONS:

1. Measure the circumference of the brake drum and calculate its radius (r), in meters.

- Torque (T) = $9.81 (S_1 - S_2) \cdot r$

Where, $S_1, S_2 \rightarrow$ Spring balance readings in kg

$r \rightarrow$ Radius of brake drum in m

9.81 → Constant to convert kg to Newton

2. Output Power (P_{out}) = $2\pi NT/60$

Where N= Speed in rpm

3. Input power (P_{in}) = $V_L \cdot I_L$ Watts

V_L =Input voltage in volts

I_L =Input current in Amps

4. % Efficiency = $(P_{out}/P_{in}) * 100$

TABULAR COLUMN:

Circumference of Brake Drum = 60cm

S.N o.	Voltage	Current	Speed in rpm	Spring Balance		$F = (S_1 - S_2) \times 9.81$	Torqu e (NM)	Output Power (W)	Input Power (W)	Efficiency η in (%)
				S_1	S_2					
1.	210	1.2	1532	0	0	0	-	-	-	-
2.	210	2.2	1500	4	1	29.43	3.4	441.43	462	95.54
3.	208	7.1	1480	8	2	58.86	6.7	871.04	1476	59.01
4.	200	9	1450	10	3	68.67	7.8	995.74	1800	55.32
5.	200	10.6	1400	12	3	88.29	10.1	1236	2120	59.24
6.	200	12	1380	13	3	98.1	11.2	1353.6	2400	56.4

Theoretical Calculations:

$$\text{Circumference } C = 2\pi R = 2 \times 3.14 \times R$$

$$F = (S_1 - S_2) \times 9.81$$

$$F = (4-1) \times 9.81 = 29.43$$

$$F = (8-2) \times 9.81 = 58.86$$

$$F = (10-3) \times 9.81 = 68.67$$

$$F = (12-3) \times 9.81 = 88.29$$

$$F = (13-3) \times 9.81 = 98.1$$

$$R = \frac{C}{2\pi} = \frac{60 \times 10^{-2}}{2 \times 3.14} = 0.09554$$

$$\text{Torque} = F \times R$$

$$T = 29.43 \times 0.09554 = 2.8117$$

$$T = 58.86 \times 0.09554 = 5.623$$

$$T = 68.67 \times 0.09554 = 6.561$$

$$T = 88.29 \times 0.09554 = 8.435$$

$$T = 98.1 \times 0.09554 = 9.372$$

$$\text{Output Power} = \frac{2\pi NT}{60}$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1500 \times 2.8117}{60} = 441.4369W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1480 \times 5.623}{60} = 871.04W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1450 \times 6.561}{60} = 995.74W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1400 \times 8.435}{60} = 1236W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1380 \times 9.372}{60} = 1353.69W$$

$$\text{Input Power } P_{in} = V \cdot I$$

$$\text{Input Power } P_{in} = 210 \times 2.2 = 462W$$

$$\text{Input Power } P_{in} = 208 \times 7.1 = 1476.8W$$

$$\text{Input Power } P_{in} = 200 \times 9 = 1800W$$

$$\text{Input Power } P_{in} = 200 \times 10.6 = 2120W$$

$$\text{Input Power } P_{in} = 200 \times 12 = 2400W$$

$$\text{Efficiency } \eta = \frac{\text{Output Power}}{\text{Input Power}}$$

$$\text{Efficiency } \eta = \frac{441.436}{462} = 95.54\%$$

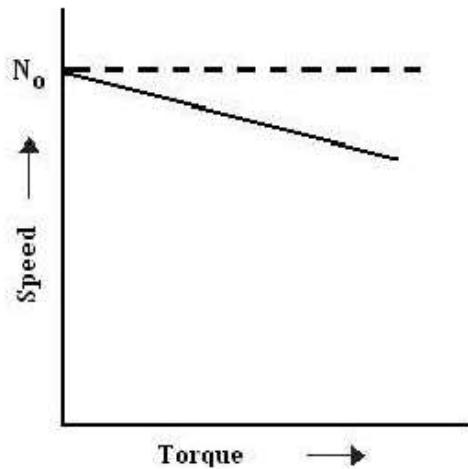
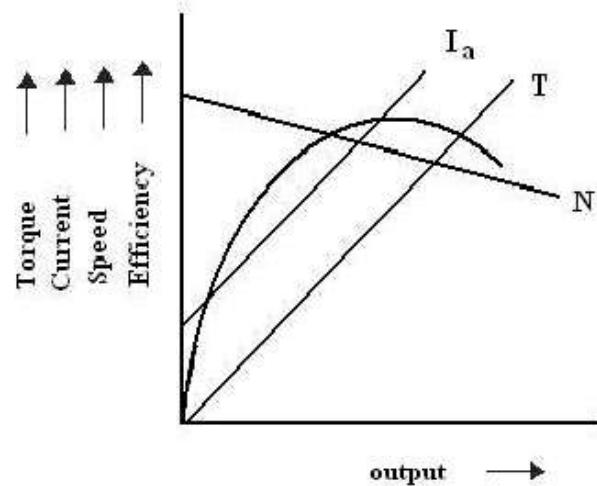
$$\text{Efficiency } \eta = \frac{871.04}{1476} = 59.01\%$$

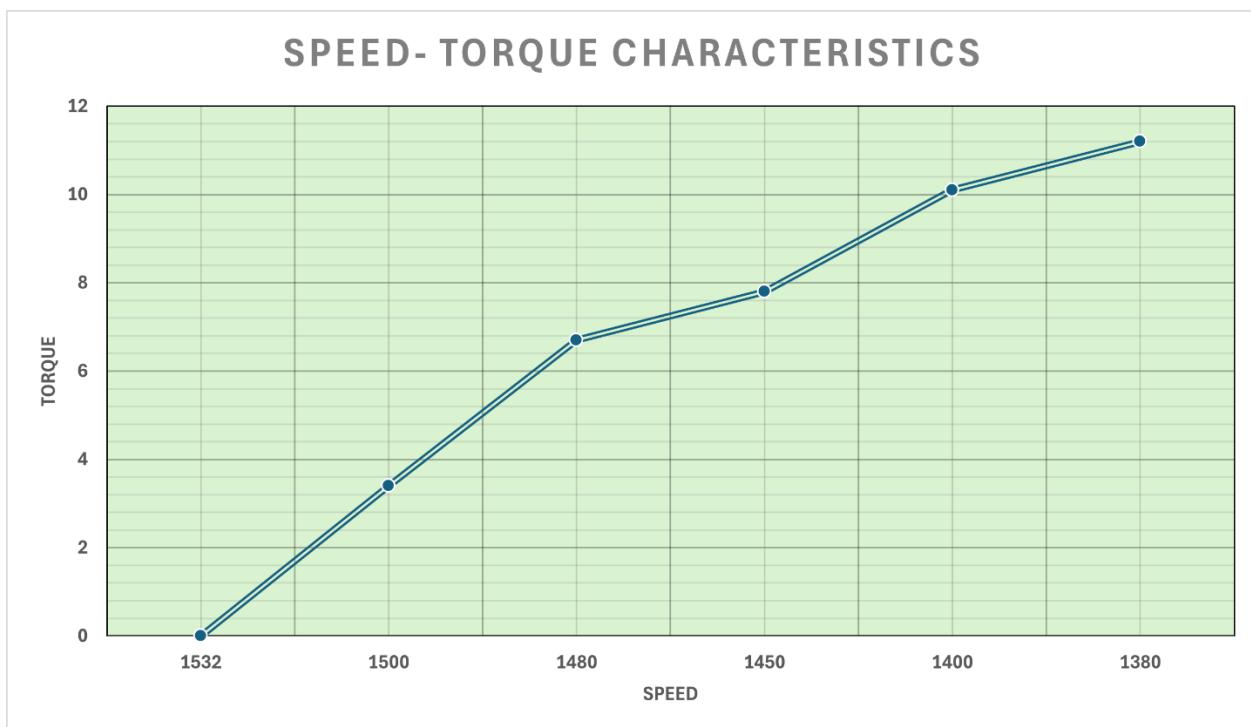
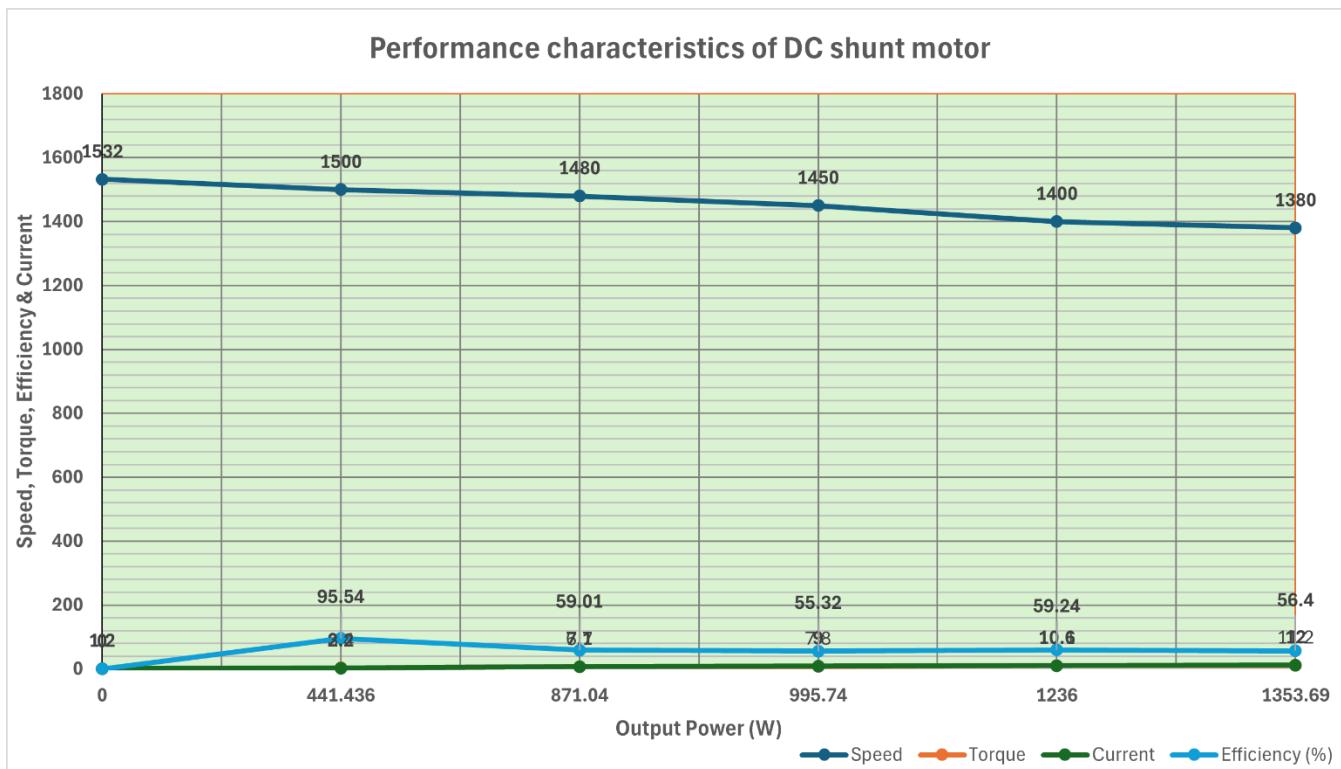
$$\text{Efficiency } \eta = \frac{995.74}{1800} = 55.32\%$$

$$\text{Efficiency } \eta = \frac{1256}{2120} = 59.24\%$$

$$\text{Efficiency } \eta = \frac{1353.69}{2400} = 56.4\%$$

MODEL GRAPH:





RESULT:

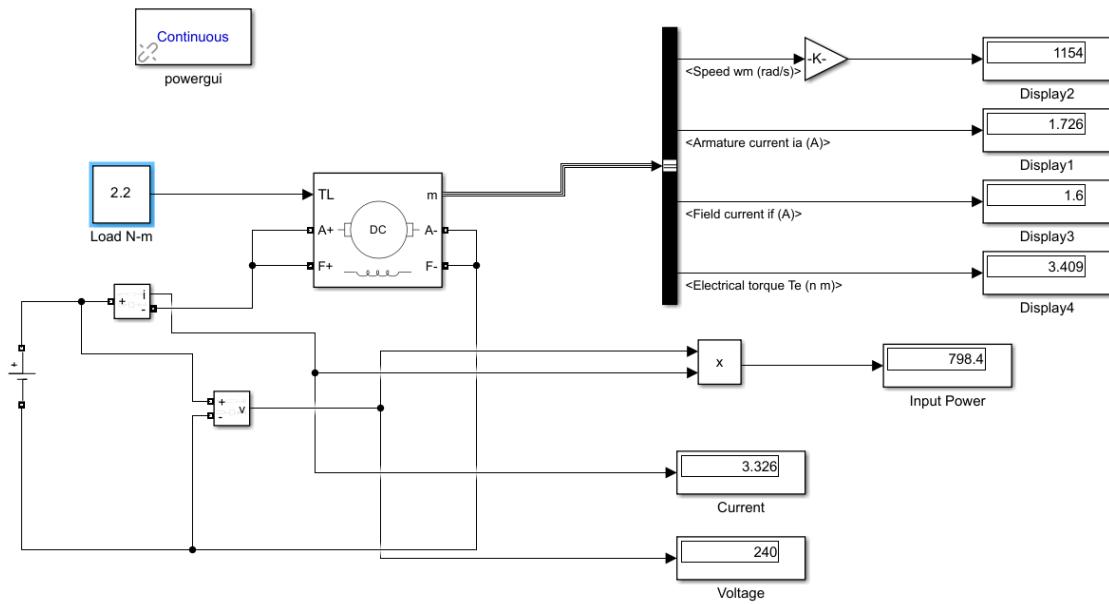
Thus the performance characteristics of DC shunt motor was obtained by conducting brake test.

Test Case 1:

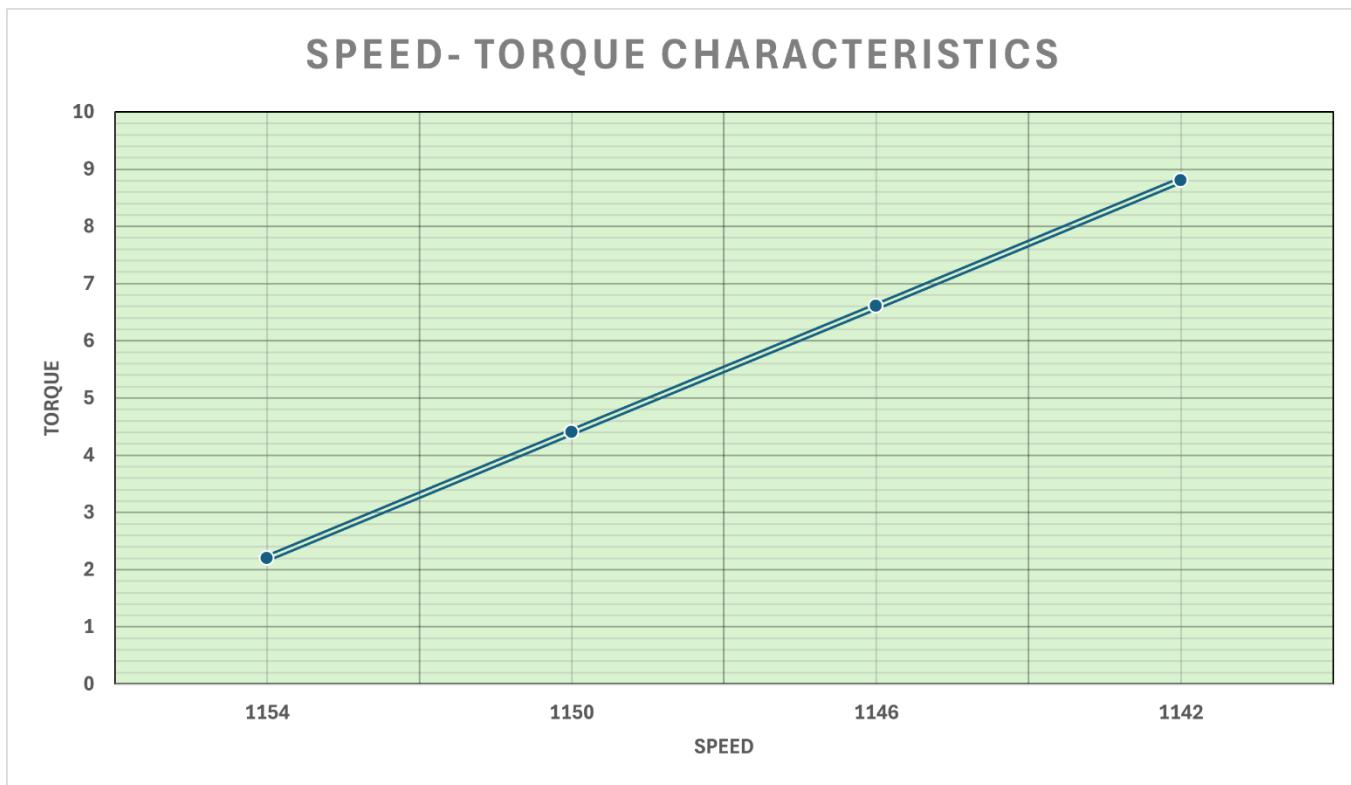
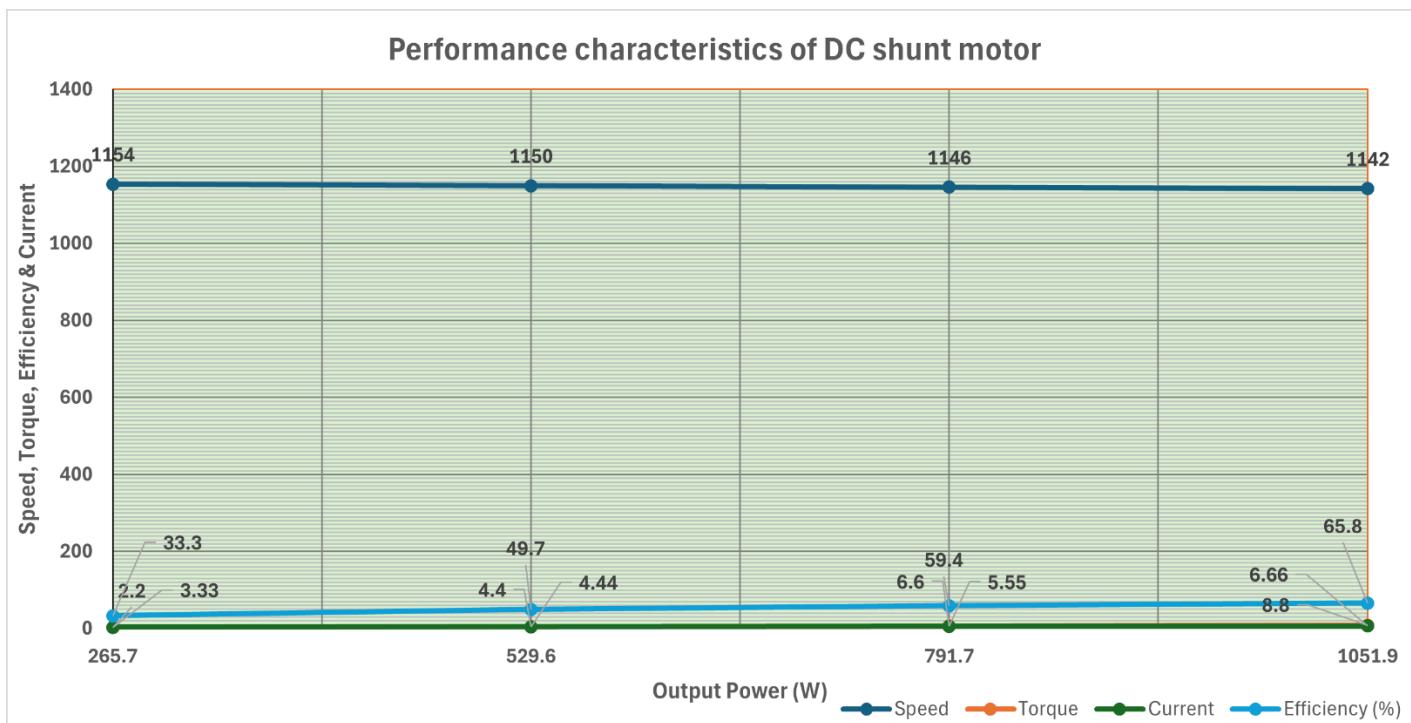
Apply a variable load (e.g., gradually increasing or decreasing load) to the motor and measure its speed, armature current, and power output.

Record the data and analyze the motor's response to changing load conditions.

Motor ratings: 5HP, 240V, 1750 RPM, Field voltage: 150V



Load Voltage	Load Current	Speed	Load Torque	Electrical Torque	Input Power	Armature current	Field Current	Output Power
240	3.326	1154	2.2	3.409	798	1.726	1.6	265.727
240	4.439	1150	4.4	5.6	1065	2.839	1.6	529.6
240	5.55	1146	6.6	7.8	1332	3.951	1.6	791.65
240	6.663	1142	8.8	9.9	1598	5.06	1.6	1051.85



Test Case 2:

How to conduct a mechanical load test to determine the characteristics of a DC shunt motor?

Load Voltage (V)	Load Current (A)	Spring Balance S1 (kg)	Spring Balance S2 (kg)	Speed (RPM)	Torque (Nm)	Input Power (W)	Output Power (W)	Efficiency (%)
220	3	2.5	1	1450	2.21	660	335.40	50.81
220	6	5	2	1400	4.41	1320	684.68	51.86
220	9	7.5	3	1350	6.69	1980	936.81	47.31
220	12	10	4	1300	8.83	2640	1202.96	45.56

Theoretical Calculations:

$$\text{Circumference } C = 2\pi R = 2 \times 3.14 \times R$$

$$F = (S_1 - S_2) \times 9.81$$

$$F = (2.5 - 1) \times 9.81 = 14.715$$

$$F = (5 - 2) \times 9.81 = 29.43$$

$$F = (7.5 - 3) \times 9.81 = 44.145$$

$$F = (10 - 4) \times 9.81 = 58.86$$

$$R = \frac{C}{2 \times \pi} = \frac{94.317 \times 10^{-2}}{2 \times 3.14} = 0.1502$$

$$\text{Torque} = F \times R$$

$$T = 14.715 \times 0.1502 = 2.21$$

$$T = 29.43 \times 0.1502 = 4.420$$

$$T = 44.145 \times 0.1502 = 6.63$$

$$T = 58.86 \times 0.1502 = 8.841$$

$$\text{Output Power} = \frac{2\pi NT}{60}$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1450 \times 2.21}{60} = 335.40W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1400 \times 4.420}{60} = 684.68W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1350 \times 6.63}{60} = 936.819W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 1300 \times 8.841}{60} = 1202.9654W$$

$$\text{Input Power } P_{in} = V \cdot I$$

$$\text{Input Power } P_{in} = 220 \times 3 = 660W$$

$$\text{Input Power } P_{in} = 220 \times 6 = 1320W$$

$$\text{Input Power } P_{in} = 220 \times 9 = 1980W$$

$$\text{Input Power } P_{in} = 220 \times 12 = 2640W$$

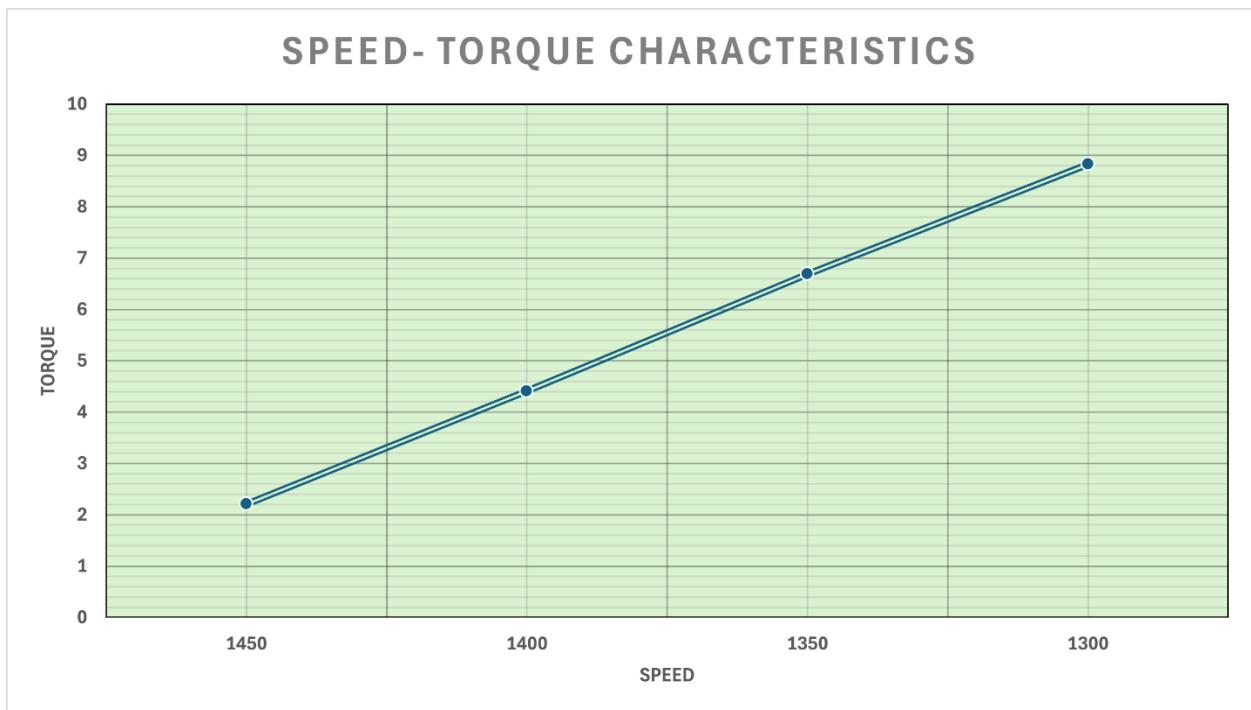
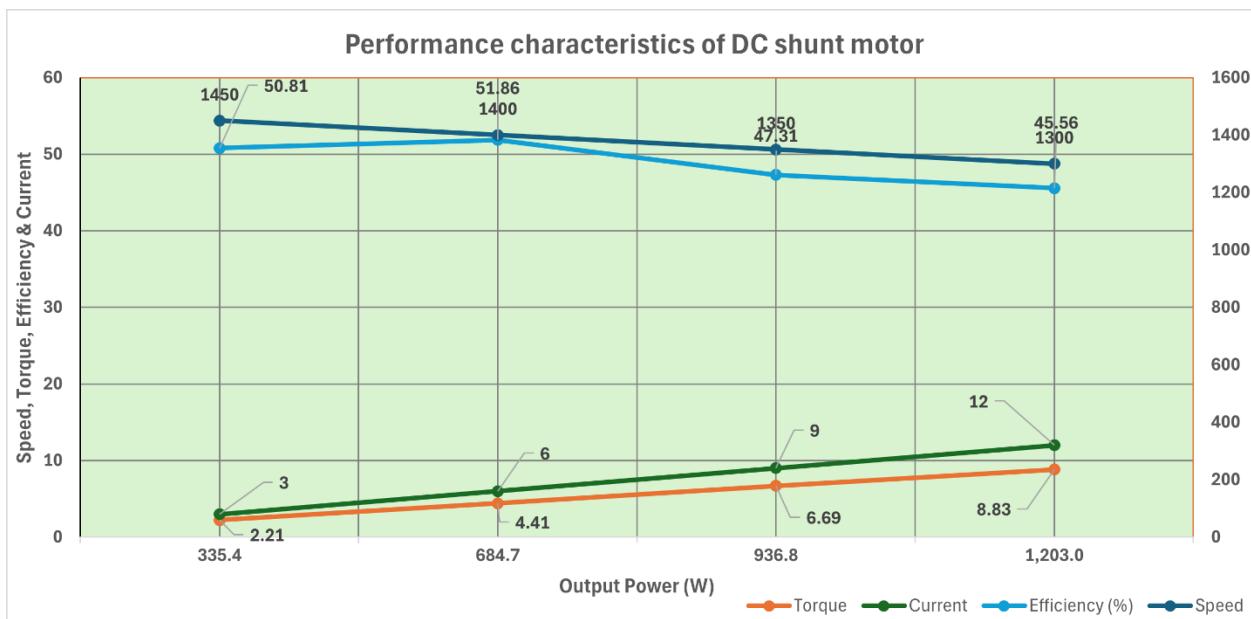
$$\text{Efficiency } \eta = \frac{\text{Output Power}}{\text{Input Power}}$$

$$\text{Efficiency } \eta = \frac{335.40}{660} = 50.81\%$$

$$\text{Efficiency } \eta = \frac{684.68}{1320} = 51.86\%$$

$$\text{Efficiency } \eta = \frac{936.819}{1980} = 47.31\%$$

$$\text{Efficiency } \eta = \frac{1202.965}{2640} = 45.56\%$$



Test Case 3:

Conduct the load test on DC shunt motor and obtain its performance characteristics.

Load Condition	Load Voltage (V)	Load Current (A)	Spring Balance S1 (kg)	Spring Balance S2 (kg)	Speed (RPM)	Torque (Nm)
No Load	220	0.5	0	0	1500	0
25% Load	220	3	2.5	1	1450	2.21
50% Load	220	6	5	2	1400	4.41
75% Load	220	9	7.5	3	1350	6.69
Full Load	220	12	10	4	1300	8.83

Theoretical Calculations:

$$\text{Circumference } C = 2\pi R = 2 \times 3.14 \times R$$

$$F = (S_1 - S_2) \times 9.81$$

$$F = (2.5 - 1) \times 9.81 = 14.715$$

$$F = (5 - 2) \times 9.81 = 29.43$$

$$F = (7.5 - 3) \times 9.81 = 44.145$$

$$F = (10 - 4) \times 9.81 = 58.86$$

$$R = \frac{C}{2 \times \pi} = \frac{94.317 \times 10^{-2}}{2 \times 3.14} = 0.1502$$

$$\text{Torque} = F \times R$$

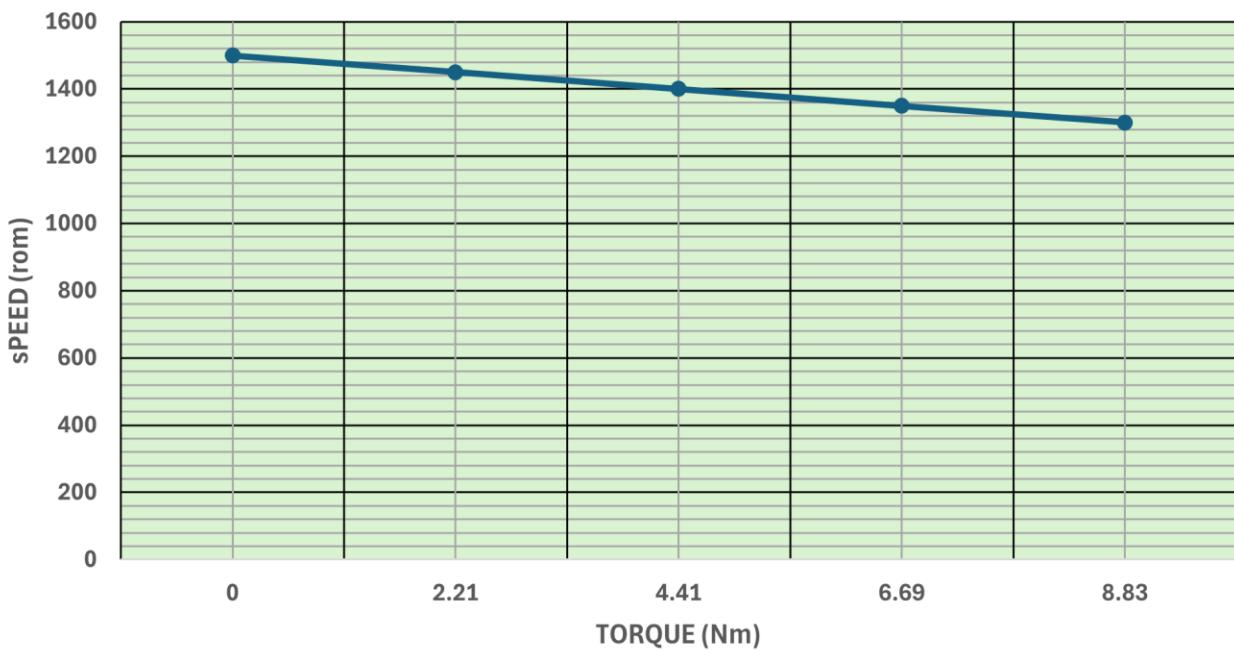
$$T = 14.715 \times 0.1502 = 2.21$$

$$T = 29.43 \times 0.1502 = 4.420$$

$$T = 44.145 \times 0.1502 = 6.63$$

$$T = 58.86 \times 0.1502 = 8.841$$

SPEED - TORQUE CHARACTERISTICS OF DC SHUNT MOTOR



Test Case 4:

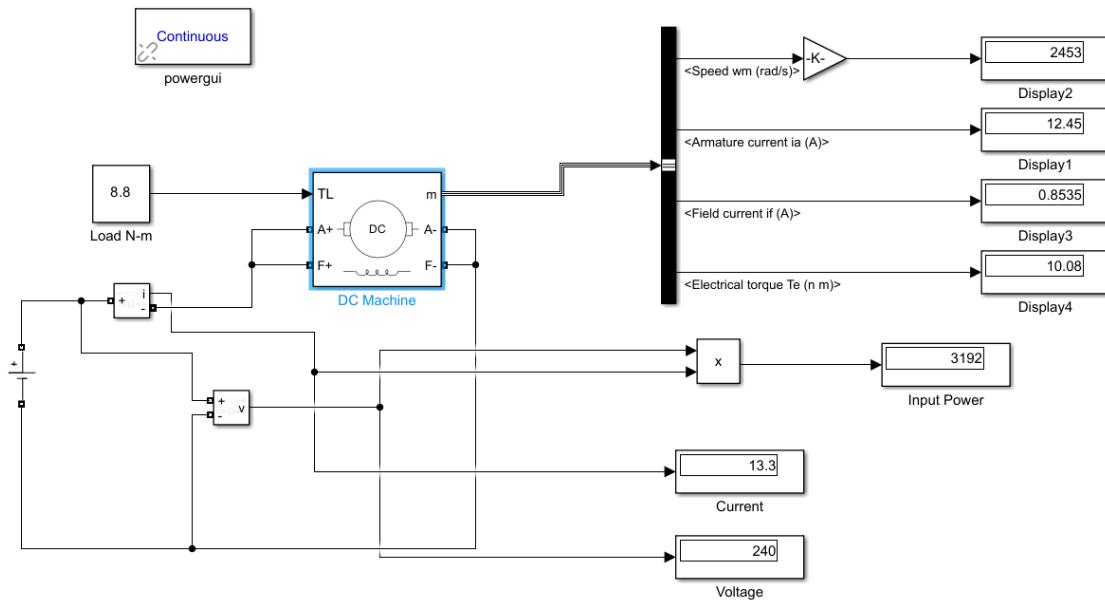
In this lab exam, you are tasked with conducting a load test on a DC shunt motor to analyze its performance characteristics. The motor's specifications are as follows:

Motor ratings: 5HP, 240V, 1750 RPM, Field voltage: 300V

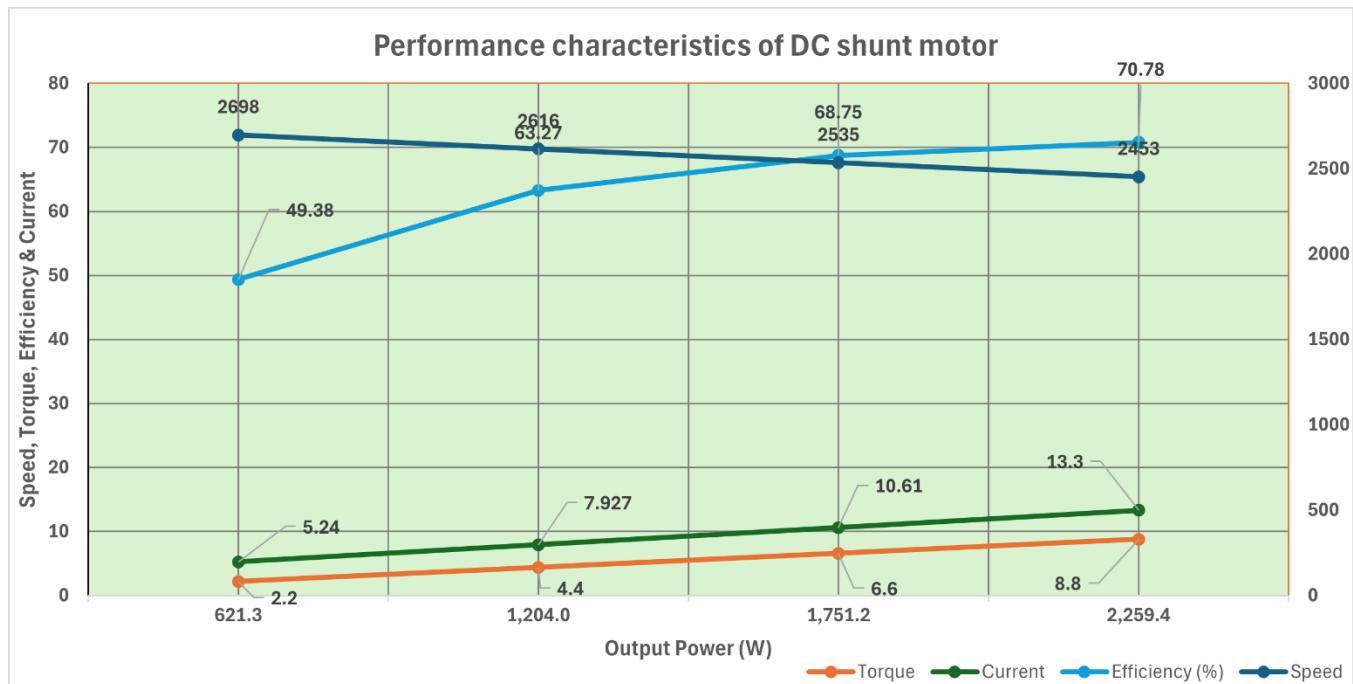
Perform the following:

Load Test:

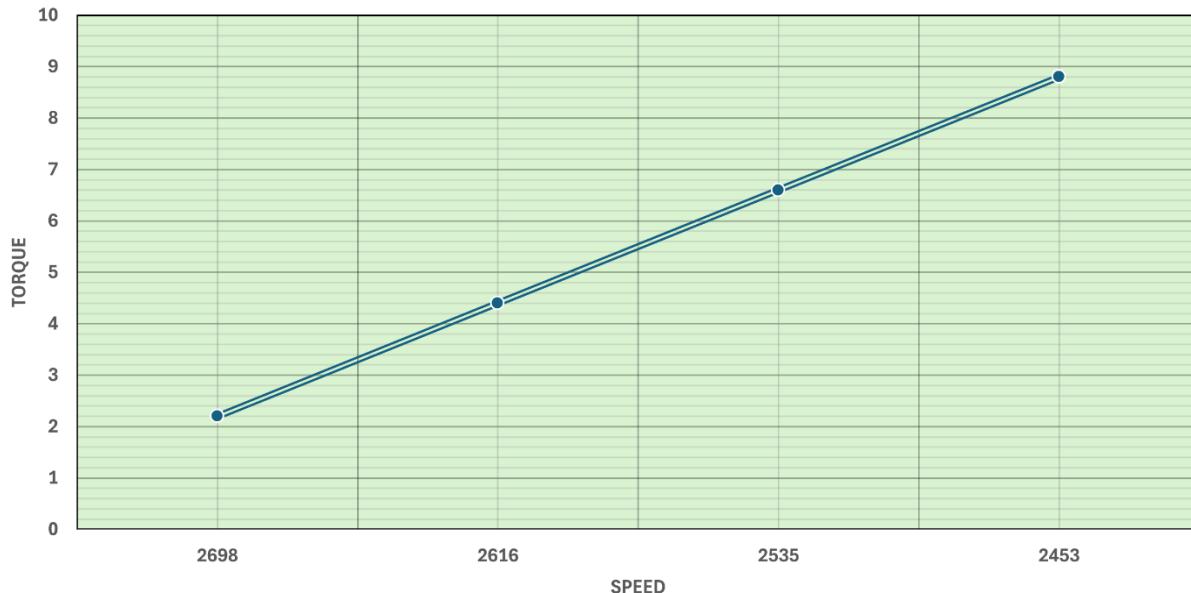
- i) Gradually apply load to the motor using a mechanical brake or other load arrangement.
- ii) Record the load torque (T_{load}) and the corresponding speed (N_{load}) for various load levels.
- iii) Ensure that the load applied does not exceed the motor's rated torque.
 - a) Determine the motor's output power at rated conditions (P_{rated}).
 - b) Calculate the efficiency (η) of the motor for each load level using the formula $\eta = (P_{out} / P_{in}) * 100$, where P_{in} is the electrical input power.



Load Voltage	Load Current	Speed	Load Torque	Electrical Torque	Input Power	Armature current	Field Current	Output Power
240	5.24	2698	2.2	3.551	1258	4.38	0.8535	621.25
240	7.927	2616	4.4	5.727	1903	7.07	0.8535	1204
240	10.61	2535	6.6	7.901	2547	9.761	0.8535	1751.17
240	13.3	2453	8.8	10.08	3192	12.45	0.8535	2259.37



SPEED- TORQUE CHARACTERISTICS



$$\text{Output Power} = \frac{2\pi NT}{60}$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 2698 \times 2.2}{60} = 621.25W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 2616 \times 4.4}{60} = 1204W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 2535 \times 6.6}{60} = 1751.17W$$

$$\text{Output Power } P_o = \frac{2 \times 3.14 \times 2453 \times 8.8}{60} = 2259.37W$$

$$\text{Input Power } P_{in} = V \cdot I$$

$$\text{Input Power } P_{in} = 240 \times 5.24 = 1258W$$

$$\text{Input Power } P_{in} = 240 \times 7.927 = 1903W$$

$$\text{Input Power } P_{in} = 240 \times 10.61 = 2547W$$

$$\text{Input Power } P_{in} = 240 \times 13.3 = 3192W$$

Expt. No. 15(a)	Staircase Wiring
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AIM:

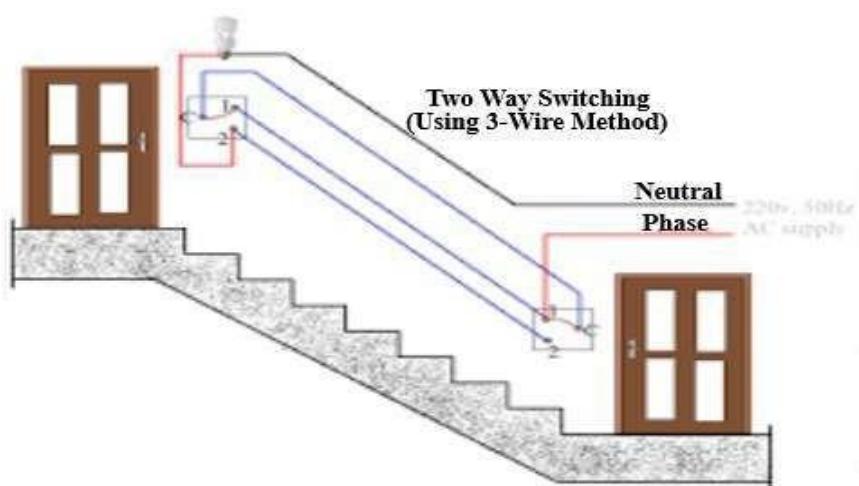
To control the status of the given lamp using two-way switches.

APPARATUS REQUIRED:

S.NO	APPARATUS	RANGE / TYPE	QUANTITY
1	Incandescent Lamp	60W/40W	1
2	SPDT (Single Pole Double Throw-Double Way Switch)	5A, 230V	2
3	Lamp holder	Pendant type	1
4	Line Tester	500V / Taparia 813	1
5	3 Pin Plug	5A, 230V	1
6	Wire Stripper Cum Cutter	Pye 950	1
7	Connecting Wires	12A / 1 sq.mm Area/ 0.7 Thickness	As Per Requirement

THEORY:

Staircase wiring is a common multi-way switching or two-way light switching connection; one light two switches wiring. One lamp is controlled by two switches from two different positions that is to operate the load from separate positions such as above or below the staircase, from inside or outside of a room, or as a two-way bed switch. The main purpose of two-way switching connection is to connect and control AC appliances and equipments from two separate locations. It is mostly used in staircase wiring where a light bulb can be controlled (Switch ON / Switch OFF) from different places, no matter you are in the upper or lower portion of stair; it does not depend on the switches position as well. You just have to press the switch button to OFF/ON to perform the switching operation. It is also used in rooms having large area which has two entry and exit gates. It is used to control any electrical (AC or DC) appliance or equipment like fan, light bulbs etc from two different places.

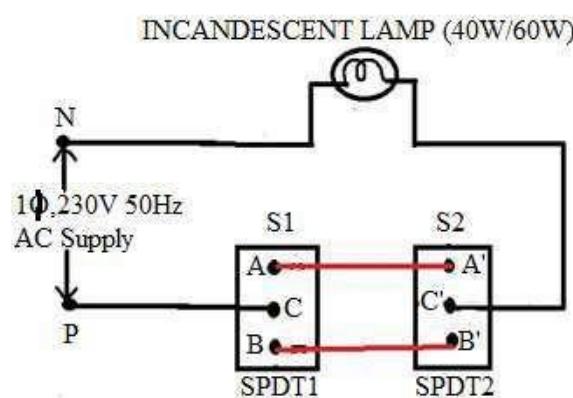


PROCEDURE:

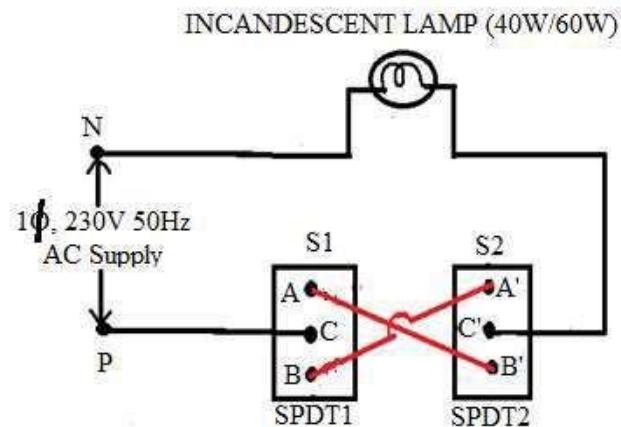
1. A piece of wire is connected to the phase side and other end to the middle point of SPDT switch1.
2. Another point of lamp holder is connected to neutral line.
3. Upper point of SPDT switch 1 is connected to the upper point of SPDT switch 2.Lower point of SPDT switch 1 is connected to the lower point of switch 2.
4. Circuit is tested that all combination of switch connection.

CIRCUIT DIAGRAM:

DIRECT CONNECTION:



INDIRECT CONNECTION:



TABULATION:

DIRECT CONNECTION:

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	ON
2	CB	C'B'	ON
3	CA	C'B'	OFF
4	CB	C'A'	OFF

INDIRECT CONNECTION:

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	OFF
2	CB	C'B'	OFF
3	CA	C'B'	ON
4	CB	C'A'	ON

RESULT:

Thus the status of the given lamp was controlled and tested under direct and indirect connection using two way switches.

Expt. No. 15(b)	Fluorescent tube wiring

AIM:

To prepare wiring for a fluorescent tube light with switch control.

APPARATUS REQUIRED:

SI No.	Apparatus	Range	Quantity
1.	Tube light with fitting	-	1
2.	Joint clips	-	As required
3.	Switch	-	1
4.	Wires	-	As required
5.	Screws	-	As required
6.	Switch board	-	1

THEORY:

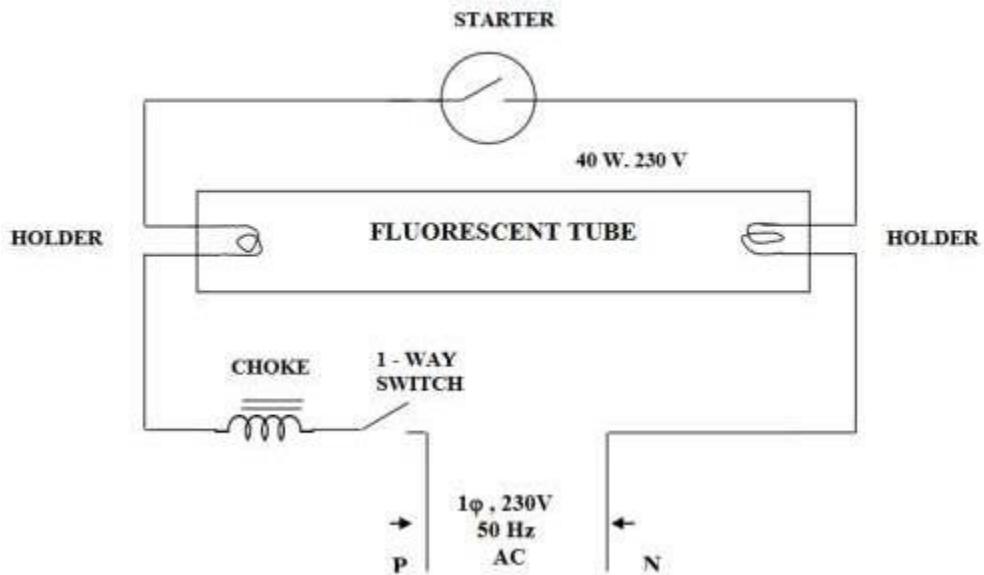
Working of the Fluorescent Tube Light:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm; its power rating is 40 W and 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light.

PROCEDURE:

1. Mark the switch and tube light location points and draw lines for wiring on the wooden board.
2. Place wires along the lines and fix them with the help of clips.
3. Fix the switch and tube light fitting in the marked positions.
4. Complete the wiring as per the wiring diagram.
5. Test the working of the tube light by giving electric supply to the circuit.

CIRCUIT DIAGRAM - TUBE LIGHT



INFERENCE:

When SW is switched on:

CONDITION	OBSERVATION
With Starter	

If the starter is removed with the tube light on, _____

RESULT:

Thus the wiring for the tube light is completed and tested.

Case (1-a) Conduct a suitable experiment to verify the below conditions.

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	ON
2	CB	C'B'	ON
3	CA	C'B'	OFF
4	CB	C'A'	OFF

Answer:

AIM:

To control the status of the given lamp using two-way switches.

APPARATUS REQUIRED:

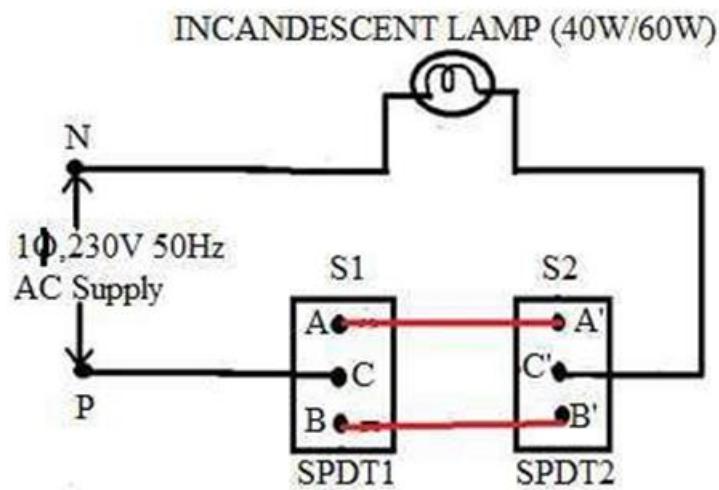
S.NO	APPARATUS	RANGE / TYPE	QUANTITY
1	Incandescent Lamp	60W/40W	1
2	SPDT (Single Pole Double Throw-Double Way Switch)	5A, 230V	2
3	Lamp holder	Pendant type	1
4	Line Tester	500V / Taparia 813	1
5	3 Pin Plug	5A, 230V	1
6	Wire Stripper Cum Cutter	Pye 950	1
7	Connecting Wires	12A / 1 sq.mm Area/ 0.7 Thickness	As Per Requirement

THEORY:

Staircase wiring is a common multi-way switching or two-way light switching connection; one light two switches wiring. One lamp is controlled by two switches from two different positions that is to operate the load from separate positions such as above or below the staircase, from inside or outside of a room, or as a two-way bed switch. The main purpose of two-way switching connection is to connect and control AC appliances and equipments from two separate locations. It is mostly used in staircase wiring where a light bulb can be controlled (Switch ON / Switch OFF) from different places, no matter you are in the upper or lower portion of stair; it does not depend on the switches position as well. You just have to press the switch button to OFF/ON to perform the switching operation. It is also used in rooms having large area which has two entry and exit gates. It is used to control any electrical (AC or DC) appliance or equipment like fan, light bulbs etc from two different places.

PROCEDURE:

1. A piece of wire is connected to the phase side and other end to the middle point of SPDT switch1.
2. Another point of lamp holder is connected to neutral line.
3. Upper point of SPDT switch 1 is connected to the upper point of SPDT switch 2.Lower point of SPDT switch 1 is connected to the lower point of switch 2.
4. Circuit is tested that all combination of switch connection.

CIRCUIT DIAGRAM:**TABULATION:**

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	ON
2	CB	C'B'	ON
3	CA	C'B'	OFF
4	CB	C'A'	OFF

RESULT:

Thus the lamp was controlled for the given conditions by constructing a circuit using two way switches.

Case (1-b) Conduct an experiment to verify the connection of fluorescent lamp to its ballast and power supply.

Answer:

AIM:

To prepare wiring for a fluorescent tube light with switch control.

APPARATUS REQUIRED:

SI No.	Apparatus	Range	Quantity
1.	Tube light with fitting	-	1
2.	Joint clips	-	As required
3.	Switch	-	1
4.	Wires	-	As required
5.	Screws	-	As required
6.	Switch board	-	1

THEORY:

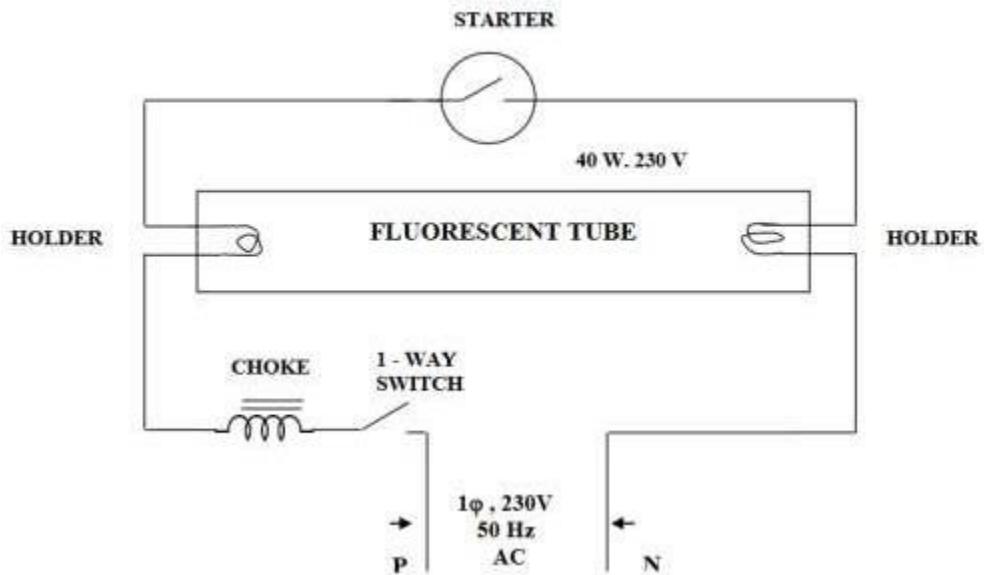
Working of the Fluorescent Tube Light:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm; its power rating is 40 W and 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light.

PROCEDURE:

1. Mark the switch and tube light location points and draw lines for wiring on the wooden board.
2. Place wires along the lines and fix them with the help of clips.
3. Fix the switch and tube light fitting in the marked positions.
4. Complete the wiring as per the wiring diagram.
5. Test the working of the tube light by giving electric supply to the circuit.

CIRCUIT DIAGRAM - TUBE LIGHT



INFERENCE:

When SW is switched on:

CONDITION	OBSERVATION
With Starter	

If the starter is removed with the tube light on, _____

RESULT:

Thus the wiring for the tube light is completed and tested.

Case (2-a) Conduct a suitable experiment to verify the below conditions.

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	OFF
2	CB	C'B'	OFF
3	CA	C'B'	ON
4	CB	C'A'	ON

Answer:

AIM:

To control the status of the given lamp using two-way switches.

APPARATUS REQUIRED:

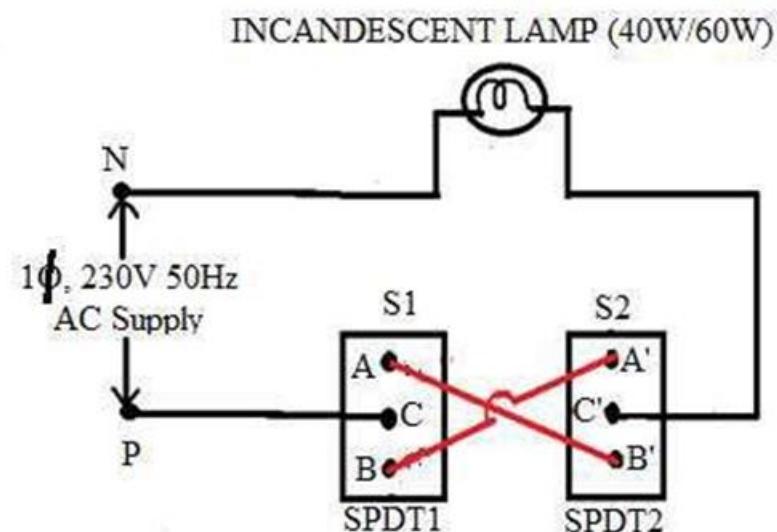
S.NO	APPARATUS	RANGE / TYPE	QUANTITY
1	Incandescent Lamp	60W/40W	1
2	SPDT (Single Pole Double Throw-Double Way Switch)	5A, 230V	2
3	Lamp holder	Pendant type	1
4	Line Tester	500V / Taparia 813	1
5	3 Pin Plug	5A, 230V	1
6	Wire Stripper Cum Cutter	Pye 950	1
7	Connecting Wires	12A / 1 sq.mm Area/ 0.7 Thickness	As Per Requirement

THEORY:

Staircase wiring is a common multi-way switching or two-way light switching connection; one light two switches wiring. One lamp is controlled by two switches from two different positions that is to operate the load from separate positions such as above or below the staircase, from inside or outside of a room, or as a two-way bed switch. The main purpose of two-way switching connection is to connect and control AC appliances and equipments from two separate locations. It is mostly used in staircase wiring where a light bulb can be controlled (Switch ON / Switch OFF) from different places, no matter you are in the upper or lower portion of stair; it does not depend on the switches position as well. You just have to press the switch button to OFF/ON to perform the switching operation. It is also used in rooms having large area which has two entry and exit gates. It is used to control any electrical (AC or DC) appliance or equipment like fan, light bulbs etc from two different places.

PROCEDURE:

1. A piece of wire is connected to the phase side and other end to the middle point of SPDT switch1.
2. Another point of lamp holder is connected to neutral line.
3. Upper point of SPDT switch 1 is connected to the upper point of SPDT switch 2. Lower point of SPDT switch 1 is connected to the lower point of switch 2.
4. Circuit is tested that all combination of switch connection.

CIRCUIT DIAGRAM:**TABULATION:**

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	OFF
2	CB	C'B'	OFF
3	CA	C'B'	ON
4	CB	C'A'	ON

RESULT:

Thus the lamp was controlled for the given conditions by constructing a circuit using two way switches.

Case (2-b) Conduct an experiment to verify the step by step process for installing a fluorescent lamp into a fixture.

Answer:

AIM:

To prepare wiring for a fluorescent tube light with switch control.

APPARATUS REQUIRED:

SI No.	Apparatus	Range	Quantity
1.	Tube light with fitting	-	1
2.	Joint clips	-	As required
3.	Switch	-	1
4.	Wires	-	As required
5.	Screws	-	As required
6.	Switch board	-	1

THEORY:

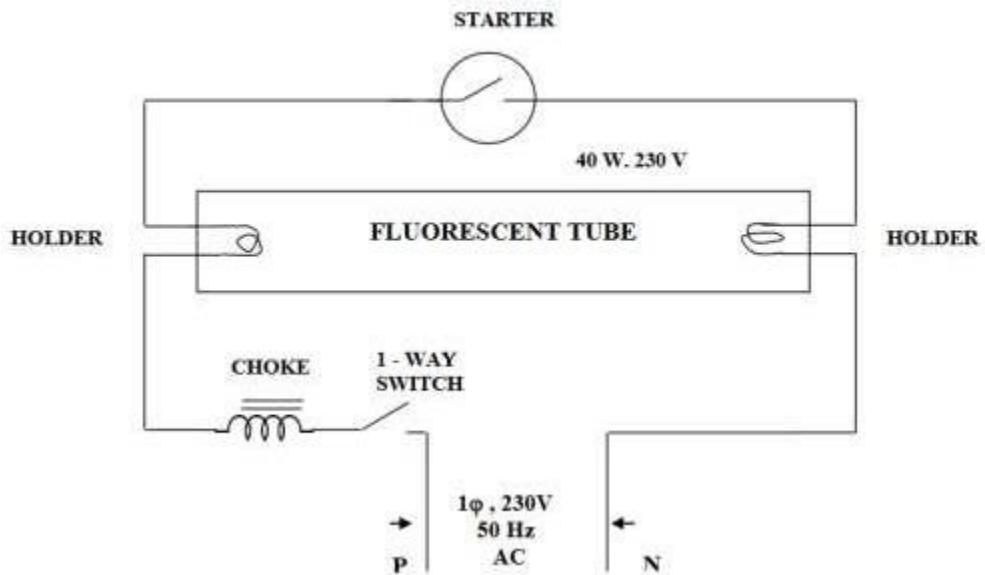
Working of the Fluorescent Tube Light:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm; its power rating is 40 W and 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light.

PROCEDURE:

1. Mark the switch and tube light location points and draw lines for wiring on the wooden board.
2. Place wires along the lines and fix them with the help of clips.
3. Fix the switch and tube light fitting in the marked positions.
4. Complete the wiring as per the wiring diagram.
5. Test the working of the tube light by giving electric supply to the circuit.

CIRCUIT DIAGRAM - TUBE LIGHT



INFERENCE:

When SW is switched on:

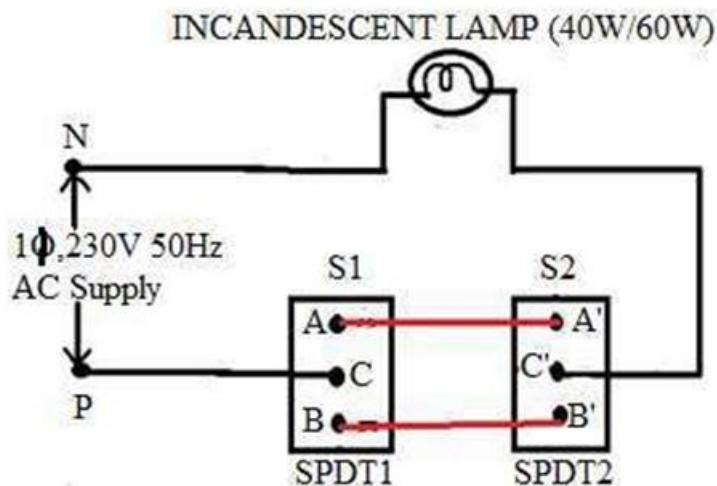
CONDITION	OBSERVATION
With Starter	

If the starter is removed with the tube light on, _____

RESULT:

Thus the wiring for the tube light is completed and tested.

Case (3-a) Conduct a suitable experiment to verify the output conditions for the diagram given below.



Answer:

AIM:

To control the status of the given lamp using two-way switches.

APPARATUS REQUIRED:

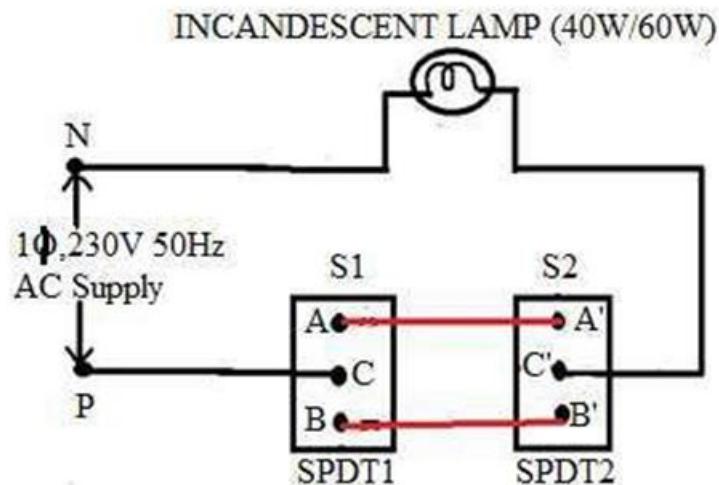
S.NO	APPARATUS	RANGE / TYPE	QUANTITY
1	Incandescent Lamp	60W/40W	1
2	SPDT (Single Pole Double Throw-Double Way Switch)	5A, 230V	2
3	Lamp holder	Pendant type	1
4	Line Tester	500V / Taparia 813	1
5	3 Pin Plug	5A, 230V	1
6	Wire Stripper Cum Cutter	Pye 950	1
7	Connecting Wires	12A / 1 sq.mm Area/ 0.7 Thickness	As Per Requirement

THEORY:

Staircase wiring is a common multi-way switching or two-way light switching connection; one light two switches wiring. One lamp is controlled by two switches from two different positions that is to operate the load from separate positions such as above or below the staircase, from inside or outside of a room, or as a two-way bed switch. The main purpose of two-way switching connection is to connect and control AC appliances and equipments from two separate locations. It is mostly used in staircase wiring where a light bulb can be controlled (Switch ON / Switch OFF) from different places, no matter you are in the upper or lower portion of stair; it does not depend on the switches position as well. You just have to press the switch button to OFF/ON to perform the switching operation. It is also used in rooms having large area which has two entry and exit gates. It is used to control any electrical (AC or DC) appliance or equipment like fan, light bulbs etc from two different places.

PROCEDURE:

1. A piece of wire is connected to the phase side and other end to the middle point of SPDT switch1.
2. Another point of lamp holder is connected to neutral line.
3. Upper point of SPDT switch 1 is connected to the upper point of SPDT switch 2.Lower point of SPDT switch 1 is connected to the lower point of switch 2.
4. Circuit is tested that all combination of switch connection.

CIRCUIT DIAGRAM:**TABULATION:**

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	ON
2	CB	C'B'	ON
3	CA	C'B'	OFF
4	CB	C'A'	OFF

RESULT:

Thus the lamp conditions were verified for the given circuit using two way switches.

Case (3-b) Conduct an experiment to test whether a fluorescent lamp is functioning correctly.

Answer:

AIM:

To prepare wiring for a fluorescent tube light with switch control.

APPARATUS REQUIRED:

SI No.	Apparatus	Range	Quantity
1.	Tube light with fitting	-	1
2.	Joint clips	-	As required
3.	Switch	-	1
4.	Wires	-	As required
5.	Screws	-	As required
6.	Switch board	-	1

THEORY:

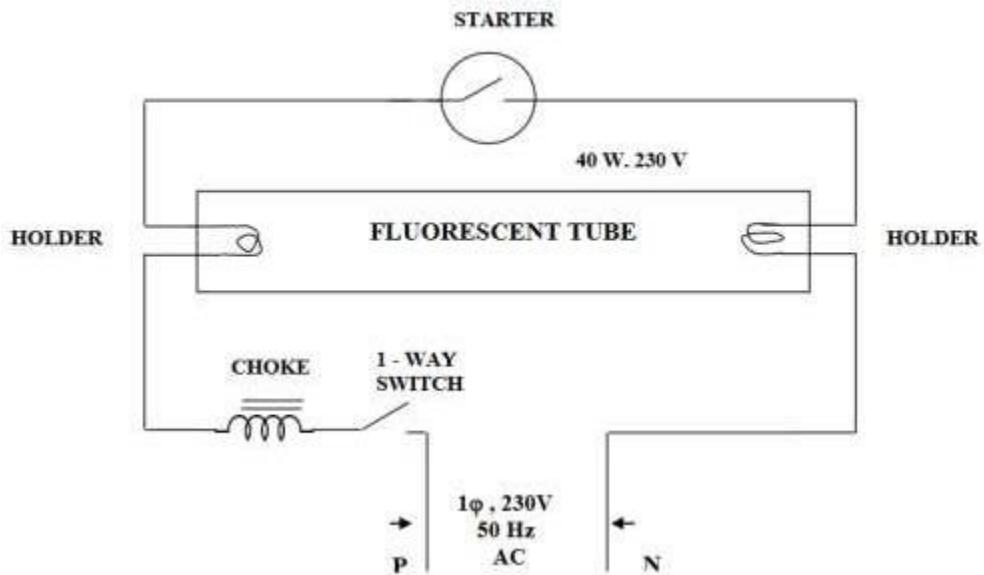
Working of the Fluorescent Tube Light:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm; its power rating is 40 W and 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light.

PROCEDURE:

1. Mark the switch and tube light location points and draw lines for wiring on the wooden board.
2. Place wires along the lines and fix them with the help of clips.
3. Fix the switch and tube light fitting in the marked positions.
4. Complete the wiring as per the wiring diagram.
5. Test the working of the tube light by giving electric supply to the circuit.

CIRCUIT DIAGRAM - TUBE LIGHT



INFERENCE:

When SW is switched on:

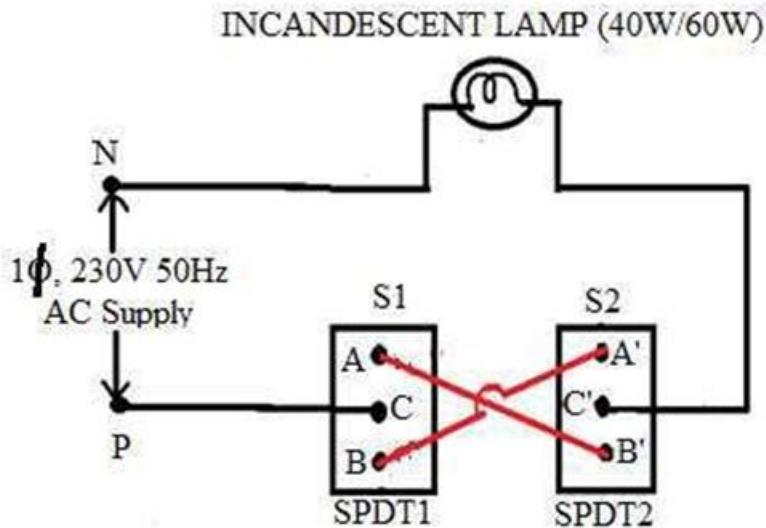
CONDITION	OBSERVATION
With Starter	

If the starter is removed with the tube light on, _____

RESULT:

Thus the wiring for the tube light is completed and tested.

Case (4-a) Conduct a suitable experiment to verify the output conditions for the diagram given below.



Answer:

AIM:

To control the status of the given lamp using two-way switches.

APPARATUS REQUIRED:

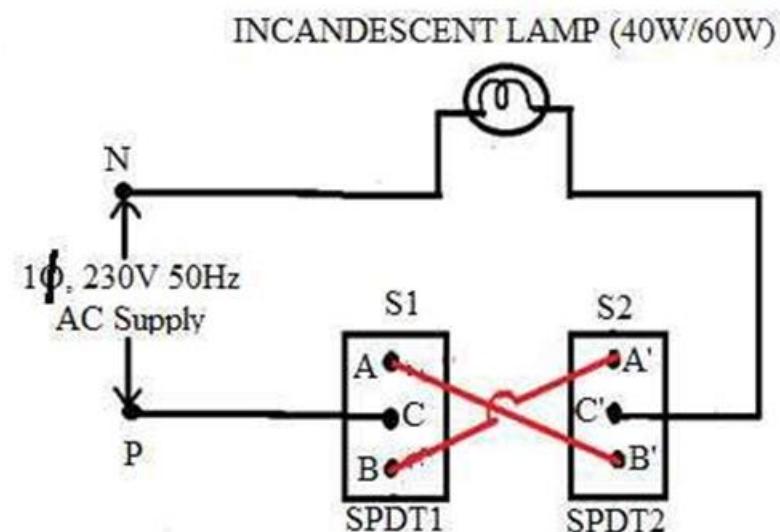
S.NO	APPARATUS	RANGE / TYPE	QUANTITY
1	Incandescent Lamp	60W/40W	1
2	SPDT (Single Pole Double Throw-Double Way Switch)	5A, 230V	2
3	Lamp holder	Pendant type	1
4	Line Tester	500V / Taparia 813	1
5	3 Pin Plug	5A, 230V	1
6	Wire Stripper Cum Cutter	Pye 950	1
7	Connecting Wires	12A / 1 sq.mm Area/ 0.7 Thickness	As Per Requirement

THEORY:

Staircase wiring is a common multi-way switching or two-way light switching connection; one light two switches wiring. One lamp is controlled by two switches from two different positions that is to operate the load from separate positions such as above or below the staircase, from inside or outside of a room, or as a two-way bed switch. The main purpose of two-way switching connection is to connect and control AC appliances and equipments from two separate locations. It is mostly used in staircase wiring where a light bulb can be controlled (Switch ON / Switch OFF) from different places, no matter you are in the upper or lower portion of stair; it does not depend on the switches position as well. You just have to press the switch button to OFF/ON to perform the switching operation. It is also used in rooms having large area which has two entry and exit gates. It is used to control any electrical (AC or DC) appliance or equipment like fan, light bulbs etc from two different places.

PROCEDURE:

1. A piece of wire is connected to the phase side and other end to the middle point of SPDT switch1.
2. Another point of lamp holder is connected to neutral line.
3. Upper point of SPDT switch 1 is connected to the upper point of SPDT switch 2.Lower point of SPDT switch 1 is connected to the lower point of switch 2.
4. Circuit is tested that all combination of switch connection.

CIRCUIT DIAGRAM:**TABULATION:**

S.NO	S1	S2	LAMP STATUS
1	CA	C'A'	OFF
2	CB	C'B'	OFF
3	CA	C'B'	ON
4	CB	C'A'	ON

RESULT:

Thus the lamp conditions were verified for the given circuit using two way switches.

Case (4-b) Conduct an experiment to configure the lamp and ballast to ensure its stable operation.

Answer:

AIM:

To prepare wiring for a fluorescent tube light with switch control.

APPARATUS REQUIRED:

SI No.	Apparatus	Range	Quantity
1.	Tube light with fitting	-	1
2.	Joint clips	-	As required
3.	Switch	-	1
4.	Wires	-	As required
5.	Screws	-	As required
6.	Switch board	-	1

THEORY:

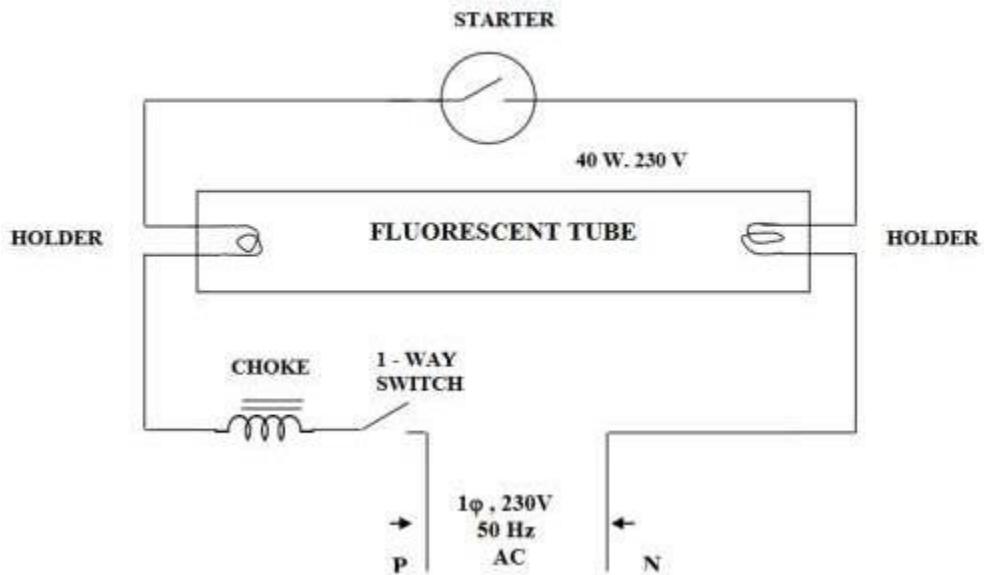
Working of the Fluorescent Tube Light:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm; its power rating is 40 W and 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light.

PROCEDURE:

1. Mark the switch and tube light location points and draw lines for wiring on the wooden board.
2. Place wires along the lines and fix them with the help of clips.
3. Fix the switch and tube light fitting in the marked positions.
4. Complete the wiring as per the wiring diagram.
5. Test the working of the tube light by giving electric supply to the Circuit.

CIRCUIT DIAGRAM - TUBE LIGHT



INFERENCE:

When SW is switched on:

CONDITION	OBSERVATION
With Starter	

If the starter is removed with the tube light on, _____

RESULT:

Thus the wiring for the tube light is completed and tested.

Exp: 15 FIND STABILITY OF A SYSTEM USING ROUTH HURWITZ CRITERION

Aim:

To determine the stability of the closed-loop system using Routh Hurwitz Criterion for the given polynomial characteristics equations.

- (i) $(s)=s^4+2s^3+3s^2+4s+5$ and
- (ii) $(s)=s^5+7s^4+6s^3+42s^2+8s+56$

Tools Used:

- (i) SCILAB software
- (ii) PC

Program code:

```
clear;
clc;
xdel(winsid());
mode(0);
s=%s;
H=s^4+2*s^3+3*s^2+4*s+5;
//H=s^5+7*s^4+6*s^3+42*s^2+8*s+56;
disp(H,'The given characteristics equation 1-G(s)H(s)=');
c=coeff(H);
len=length(c);
r=routh_t(H);
disp(r,"Rouths table=");
x=0;
for i=1:len
if(r(i,1)<0)
x=x+1;
end
end
if(x>=1)
printf("From Rouths table, it is clear that the system is unstable.")
else
printf("From Rouths table, it is clear that the system is stable.")
end
```

Simulation output:

```
Scilab 6.0.2 Console

The given characteristics equation 1-G(s)H(s)=

      2   3   4
5 +4s +3s +2s +s

Rouths table=

 1.   3.   5.
 2.   4.   0.
 1.   5.   0.
-6.   0.   0.
 5.   0.   0.

From Rouths table, it is clear that the system is unstable.
--> |
```

```
Scilab 6.0.2 Console

The given characteristics equation 1-G(s)H(s)=

      2   3   4   5
56 +8s +42s +6s +7s +s

Rouths table=

 1.       6.     8.
 7.       42.    56.
 28.      84.    0.
 21.      56.    0.
 9.3333333 0.    0.
 56.      0.    0.

From Rouths table, it is clear that the system is stable.
--> |
```

Marks Obtained:

Theoretical Calculations	20	
Observation	20	
Execution of practice examples	30	
Viva	10	
Record	20	
Total Score	100	
Date of experiment		
Date of record submission		Faculty signature

RESULT:

Thus the stability of a system using routh hurwitz criterion is verified.

Aim: To Study the Function of Three Phase Induction Motor Drive System in E-Mobility.

Requirements:

1. 750W Three Phase Induction Motor	1 Nos.
2. Panel with DC Voltmeter, DC Ammeter & AC Meter	1 Nos.
3. 750W Variable Frequency AC Drive (VFD)	1 Nos.
4. Battery Emulator/DC Drive	1 Nos.
5. Human Machine Interface (HMI)	1 Nos.
6. 12 V Alternator with 12V Batteries for Electrical Loading	1 Nos.

Theory:

Three-phase AC induction motors play a very important role in industry due to its low price and simplicity. The induction motor is used to convert three-phase AC power into mechanical power. When the load on an induction motor increases the percentage of slip is increase, which leads to decrease the speed of induction motor while constant speed in industry is very important. The speed of induction motor is controlled by variable frequency drive (VFD) automatically through controller. It is simple and efficient method to control the speed because speed depends upon voltage, pole and frequency. Poles are fix inbuilt in the motor so we cannot change it and speed control through VFD is simple and energy efficient method. This technique implemented on hardware. So this technique is robust and simpler to implement.

Synchronous Speed:

When Alternating current (AC) is applied to the stator of a three phase motor, a rotating magnetic field is setup. This rotating magnetic field moves with a speed called synchronous speed. The Synchronous speed can be calculated as follows: 120 times the frequency (F), divided by the number of poles (P):

$$N_s = \frac{120F}{P}$$

The synchronous speed decreases as the number of poles increases. The table below shows the synchronous speed associated with various numbers of poles at supply frequencies of 50Hz and 60Hz:

No. of Poles	Synchronous Speed @ 50Hz	Synchronous Speed @ 60Hz
2	3000	3600
4	1500	1800
6	1000	1200
8	750	900
12	500	600

Rated Speed: The speed of operation of an AC motor when fully loaded at rated voltage is called the rated speed. It is usually given in RPM on an electric motor nameplate. The rated speed is the speed of the rotor. **Slip:** The speed of the rotor magnetic field in an induction motor lags slightly behind the synchronous speed of the changing stator magnetic field. This difference in speed between rotor and stator fields is called slip and is measured in %. The slip of an AC motor is a key factor and is necessary to produce torque. The greater the load (torque), the greater slip will be.

The formula for calculating motor slip is given by:

$$\text{Slip} = \frac{N_s - N}{N_s}$$

Where :

N_s = Synchronous speed

N = Rotor speed

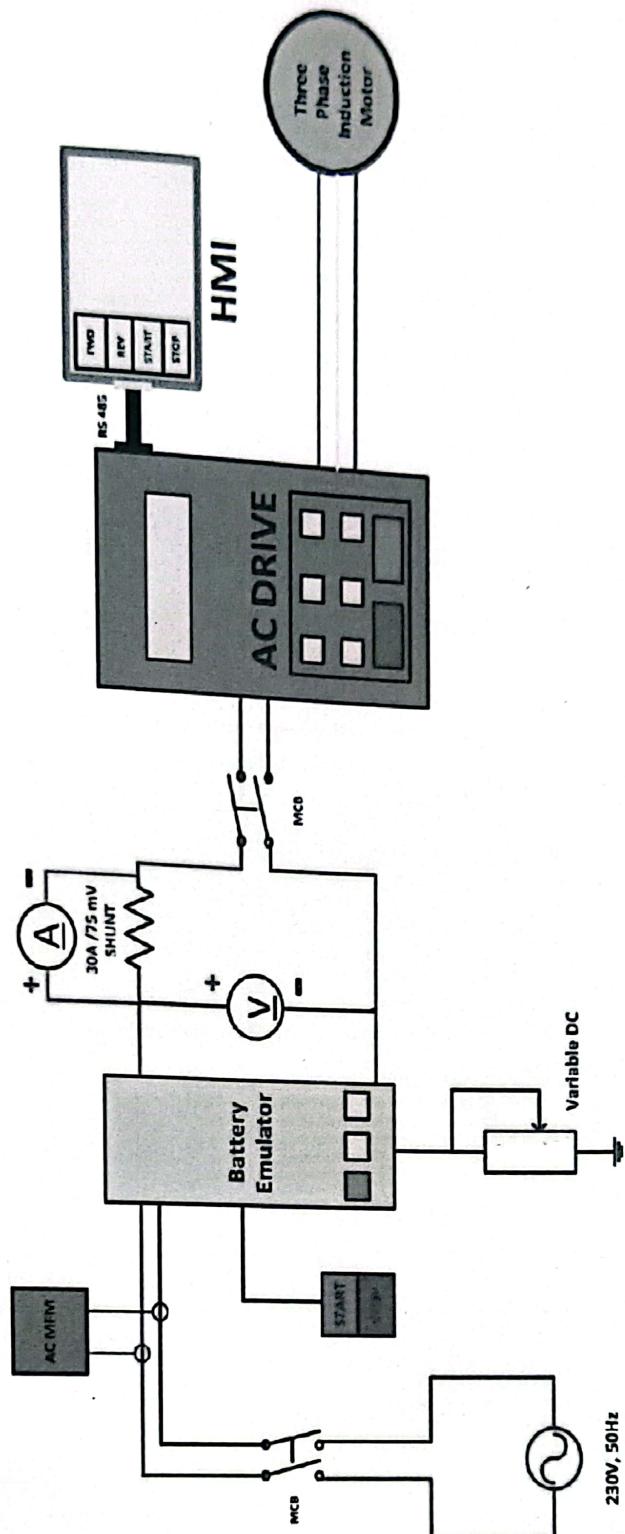
Note that rotor speed is the same as the rated speed of the AC motor as given on the motor nameplate.

The two main features of variable frequency drive are **adjustable speeds and soft start/stop** capabilities. These two features make VFD's a powerful controller to control the AC motors in industrial terms, **AC drive is also called as variable frequency drive (VFD), variable speed drive (VSD), or adjustable speed drive (ASD), Adjustable frequency drive (AFD), variable voltage variable frequency drive (VVVFID).**

Though there are different types of VFDs (or AC drives), all of them work on the same principle that converting fixed incoming voltage and frequency into variable voltage and frequency output. The **frequency** of the drive determines the how fast motor should run while the combination of **voltage (V) and frequency (F)** decides the amount of torque that the motor generates.

Procedure:

Three Phase AC Induction Motor Based Model Connection Diagram



1. Give AC Supply to Meter(s), Battery Emulator/DC Drive & HMI etc.
2. Fully Rotate Potentiometer of DC Control connected with Battery Emulator.
3. Select Forward/Reverse Mode Using HMI.
4. Vary the Frequency Using VFD.

5. Connect 12V Battery in Excitation Panel of Alternator according to Connection Diagram & Make sure to Switch on the Toggle switch
6. Calculate different values given on the below Table to Understand the working Characteristics of VFD & Three Phase Induction Motor Drive System.

Cautions:

1. Do not connect overvoltage supply.
2. Check proper connection before testing.
3. Do not overload the Motor.

Calculations:

S. No.	Frequency (f)	Output Voltage (V)	Ratio = V/f	RPM Calculated (Ns=120f/P)	Tachometer (Rotor) RPM	Slip
1						
2						
3						

Load/ Charging current Across Alternator 0 V	Load/ Charging current Across Alternator 12 V Battery 1 No	Load/ Charging current Across Alternator 12 V Batteries 2 Nos in parallel

Result: Thus, the test on Three Phase Induction Motor Drive System inE-Mobility is Performed Successfully.



3 ~ Ind. Motor

IE2

IS 12615



Amb. 50 °C Duty S1

Encl. TEFC

CML-7800028114

Type 2HE2 083-0403

Wt. 17 kg

Brg 6204ZZ/6204ZZ

In.CI. F

Fr 80

S.No. 061B N 80095809

IP 55

Hz	V	kW / HP	A	RPM	%ER	PF
50	415	0.75/1.0	17	1415	79.6	0.77

±5% ±10%

MADE IN INDIA

AC Drive Control



0 , 167 , 333 , 500 , 667 , 833 , 1000 , 1167 , 1333 , 1500

Set Frequency

16.00

Bus Voltage

33.64

Output Voltage

72

Output Current

0.17

RPM

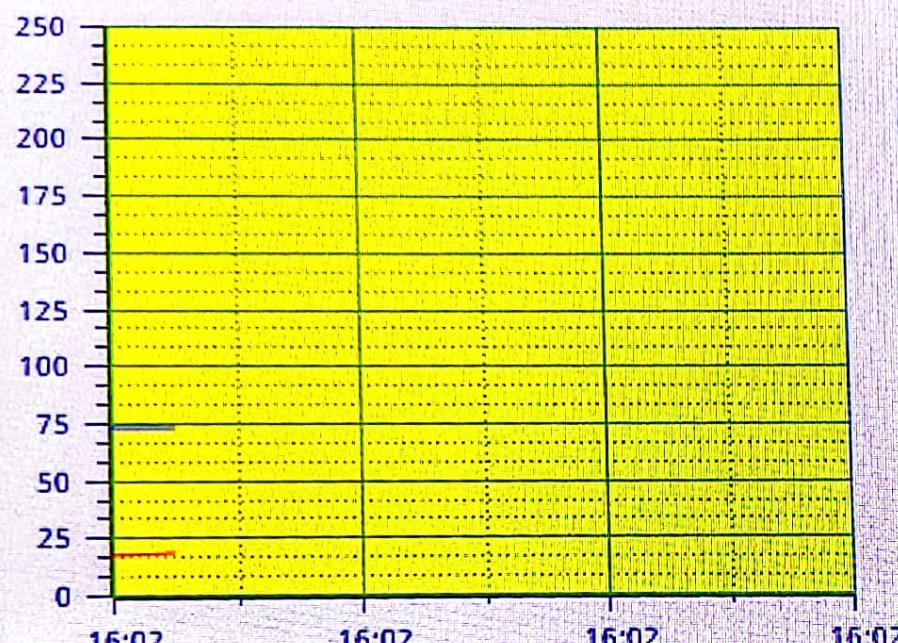
480

Output Power

81

Output Torque

0.59



Control

Start

Stop

1500
1250
1000
750
500
250
0

AC Drive Control



0 167 333 500 667 833 1000 1167 1333 1500

Set Frequency

12.00

Bus Voltage

33.63

Output Voltage

54

Output Current

0.17

RPM

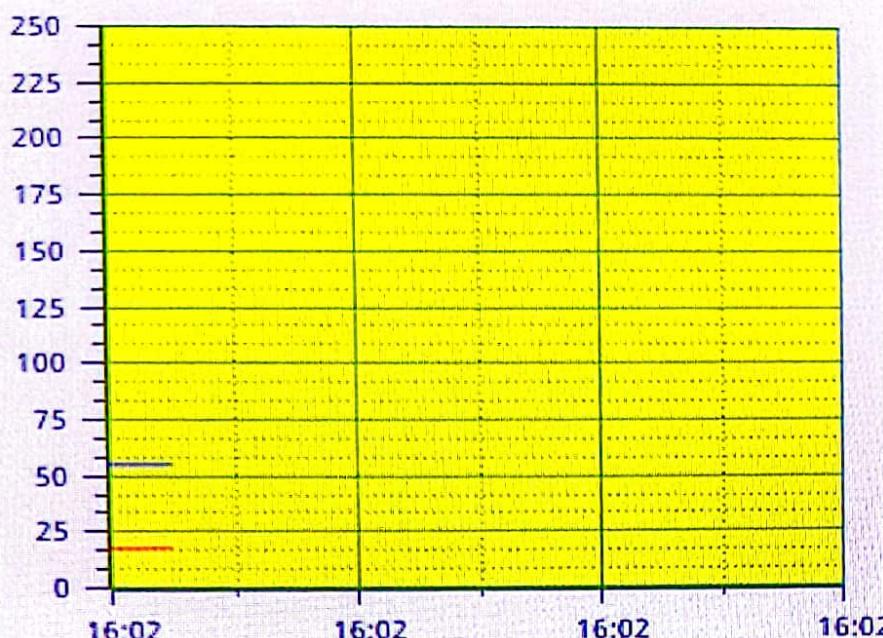
360

Output Power

54

Output Torque

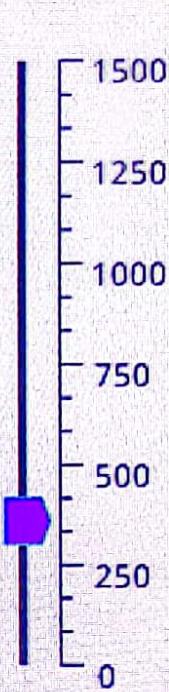
0.89



Control

Start

Stop



AC Drive Control



0 167 333 500 667 833 1000 1167 1333 1500

Set Frequency

18.00

Bus Voltage

33.88

Output Voltage

80

Output Current

0.18

RPM

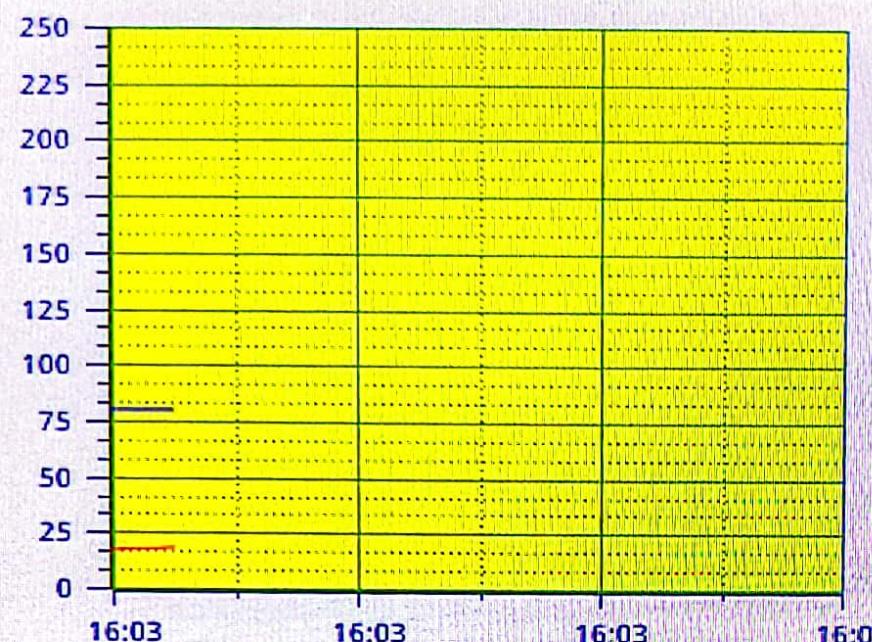
540

Output Power

81

Output Torque

0.48



Control



1500
1250
1000
750
500
250
0

AC Drive Control



Set Frequency

40.00

Bus Voltage

33.53

Output Voltage

177

Output Current

0.18

RPM

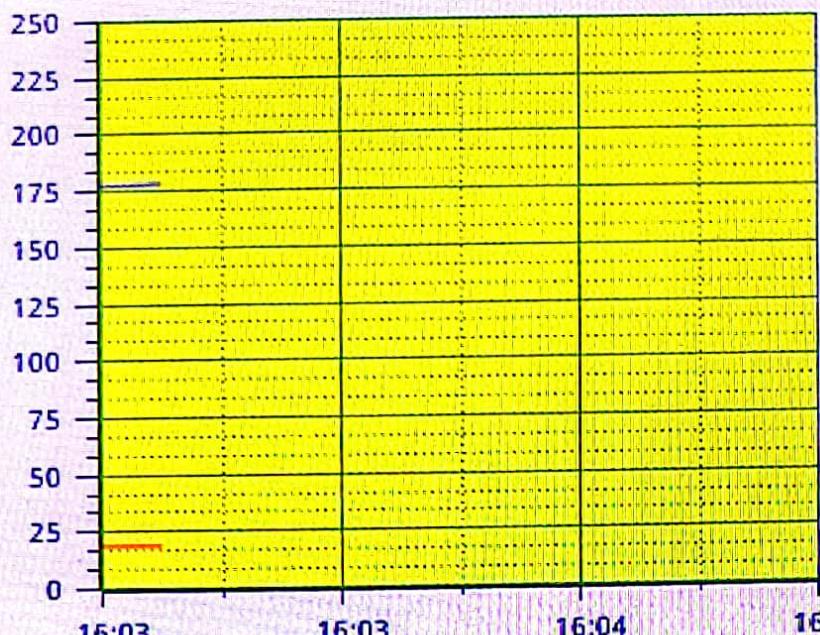
1200

Output Power

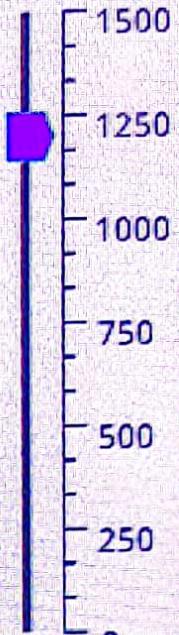
122

Output Torque

0.41



Control



AC Drive Control



0 167 333 500 667 833 1000 1167 1333 1500

Set Frequency

50.00

Bus Voltage

33.42

Output Voltage

221

Output Current

0.17

RPM

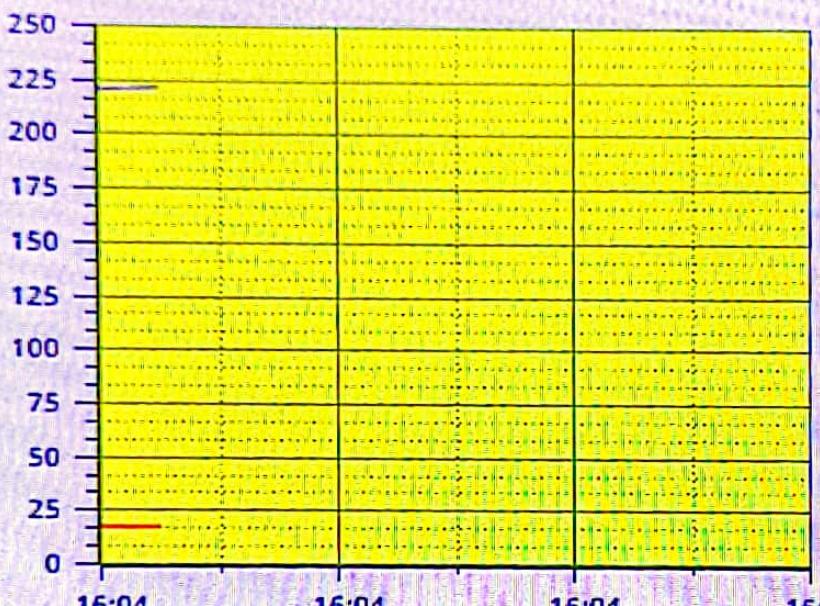
1500

Output Power

135

Output Torque

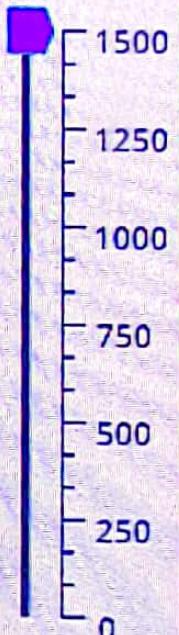
0.51



Control

Start

Stop



EX NO:17	
DATE:	Generation of Common Discrete Time Signals

Aim

Generate and plot the Unit Impulse Signal, Unit Step Signal, Unit Ramp Signal, Sinusoidal Signal, Exponential Signal: For each signal Write the SCILAB code to generate the signal. Plot the signal and label the axes appropriately.

using SCILAB:

Unit Impulse Signal, Unit Step Signal, Unit Ramp Signal, Sinusoidal Signal, Exponential Signal: For each signal Write the SCILAB code to generate the signal. Plot the signal and label the axes appropriately.

Software Required

1. Scilab 6.1.0

Procedure:

- Start the scilab Program
- Open scinotes , type the program and save the program in current directory
- Compile and run the program
- If any error occur in the program, correct the error and run the program
- For the output , see the console window
- Stop the program

Theory:

Discrete-time signals are a fundamental concept in digital signal processing and communication. They represent variations in amplitude over discrete points in time. Here, I'll provide a brief overview of some common discrete-time signals and their characteristics:

Unit Step Signal ($u[n]$): The unit step signal is a basic discrete-time signal that takes the value 1 for non-negative time indices ($n \geq 0$) and 0 otherwise. It is often used to model the onset of events or changes in a system.

Impulse Signal ($\delta[n]$): The impulse signal is also known as the discrete-time delta function. It has a value of 1 at $n = 0$ and is zero for all other time indices. It's a

fundamental signal in signal processing and is used to represent discrete-time impulses or impulses in discrete-time systems.

Exponential Signal: An exponential discrete-time signal is defined as $x[n] = A * \alpha^n$, where A is the amplitude and α is the exponential factor. Depending on whether α is greater or less than 1, the signal can grow or decay exponentially with time.

Sinusoidal Signal: A sinusoidal discrete-time signal has the form $x[n] = A * \cos(\omega n + \phi)$, where A is the amplitude, ω is the angular frequency, n is the time index, and ϕ is the phase shift. Sinusoidal signals exhibit periodic behavior and are a fundamental representation of oscillations.

Ramp Signal: A ramp signal is a linearly increasing or decreasing signal with time. It's given by $x[n] = a * n$, where ' a ' is the slope of the ramp. The ramp signal is commonly used to model linear changes or trends.

Random Signal: A random signal represents random variations or noise in a system. It's often generated using a random number generator. In digital communication, noise can introduce errors in the received signal, impacting the quality of communication.

Program:

```
//UNIT IMPULSE SIGNAL
clear all;
close ;
N=5; //SET LIMIT
t1 = -5:5;
x1 =[ zeros (1 , N ) ,ones (1 ,1) ,zeros (1 , N ) ];
subplot (2 ,4 ,1);
plot2d3 ( t1 , x1 )
xlabel ( ' tim e ' );
ylabel ( ' Ampli tude ' );
title ( ' Uni t im p ul s e s i g n a l ' );
//UNIT STEP SIGNAL
t2 = -5:5;
x2 =[ zeros (1 , N ) ,ones (1 , N +1) ];
subplot (2 ,4 ,2);
plot2d3 ( t2 , x2 )
xlabel ( ' tim e ' );
ylabel ( ' Ampli tude ' );
title ( ' Uni t s t e p s i g n a l ' );
//EXPONENTIAL SIGNAL
t3 =0:1:20;
```

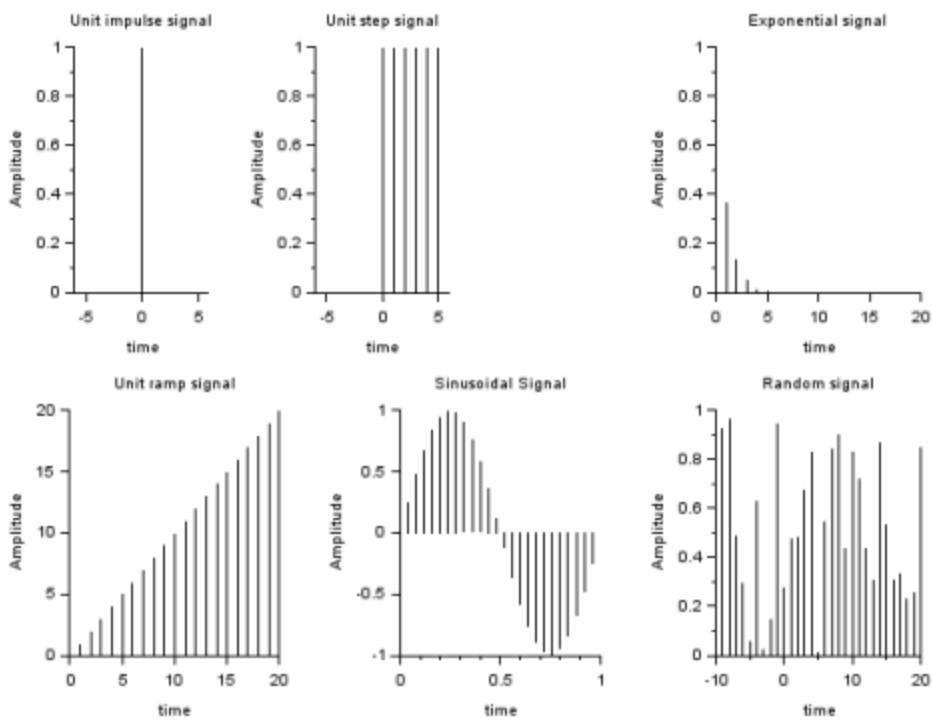
```

x3 =exp( - t3 ) ;
subplot (2 ,3 ,3) ;
plot2d3 ( t3 , x3 ) ;
xlabel ( ' time ' ) ;
ylabel ( ' Amplitude ' ) ;
title ( ' Exponential signal ' ) ;

//UNIT RAMP SIGNAL 4
t4 =0:20;
x4 = t4 ;
subplot (2 ,3 ,4) ;
plot2d3 ( t4 , x4 ) ;
xlabel ( ' time ' ) ;
ylabel ( ' Amplitude ' ) ;
title ( ' Unit ramp signal ' ) ;
//SINUSOIDAL SIGNAL
t5 =0:0.04:1;
x5 =sin (2* %pi * t5 ) ;
subplot (2 ,3 ,5) ;
plot2d3 ( t5 , x5 ) ;
title ( ' Sinusoidal signal ' ) ;
xlabel ( ' time ' ) ;
ylabel ( ' Amplitude ' ) ;
//RANDOM SIGNAL
t6 = -10:1:20;
x6 = rand (1 ,31) ;
subplot (2 ,3 ,6) ;
plot2d3 ( t6 , x6 ) ;
xlabel ( ' time ' ) ;
ylabel ( ' Amplitude ' ) ;
title ( ' Random signal ' ) ;

```

Output:



Result:

The following discrete-time signals were successfully generated and plotted using SCILAB: For each signal, the plots were labeled appropriately, with the x-axis representing time (n) and the y-axis representing the signal values.

EX NO: 18	
DATE:	DIT-FFT and DIF-FFT Algorithm

(i) Given a sequence $x[n]=[1,-1,-1,-1,1,1,1,-1]$ compute the DFT using the DIT-FFT algorithm. The sequence exhibits real and symmetric properties. How does symmetry affect the twiddle factor calculations in the DIT-FFT algorithm?

Aim

(i) To Compute the DFT of given Sequence $x[n]=[1,-1,-1,-1,1,1,1,-1]$ using DIT-FFT Algorithm.

Software Required

Scilab 6.1.0

Procedure:

- Start the scilab Program
- Open scinotes ,type the program and save the program in current directory
- Compile and run the program
- If any error occur in the program,correct the error and run the program
- For the output ,see the console window
- Stop the program

Theory:

The Decimation-in-Time Fast Fourier Transform (DIT-FFT) algorithm is an efficient method to compute the Discrete Fourier Transform (DFT) of a sequence. The FFT algorithm reduces the computational complexity of the DFT from

The DFT of a sequence $x[n]$ of length N is given by:

$$X[k] = \sum_{n=0}^{N-1} x[n] \cdot e^{-j \frac{2\pi k n}{N}}, \quad k = 0, 1, 2, \dots, N-1$$

DIT-FFT Algorithm

The DIT-FFT algorithm is a divide-and-conquer approach that breaks down the DFT computation into smaller parts, recursively decimating the sequence into smaller subsequences. The key idea behind DIT-FFT is to separate the original sequence into even-indexed and odd-indexed terms, recursively applying the FFT on these smaller sequences.

Program

```
clear;
clc ;
close ;
x = [1,-1,-1,-1,1,1,1,-1];
//FFT Computation
X = fft (x , -1);
disp(X,'X(z) =');
```

Output

```
column 1 to 5
0 - 1.4142136 + 3.4142136i  2. - 2.i  1.4142136 - 0.5857864i  4.
column 6 to 8
1.4142136 + 0.5857864i  2. + 2.i - 1.4142136 - 3.4142136i
```

Result: Thus the DFT of the sequence $x[n]=[1,-1,-1,-1,1,1,1,-1]$ using the DIT-FFT algorithm results in the expected frequency components, confirming the correct implementation of the algorithm.

(ii) Given a sequence $x[n]=[1,2,3,4,4,3,2,1]$ compute the DFT using the DIF-FFT algorithm. The sequence exhibits real and symmetric properties. How does symmetry affect the twiddle factor calculations in the DIF-FFT algorithm?

Aim

To compute the DFT of the sequence $x[n]=[1,2,3,4,4,3,2,1]$ using the Decimation-in-Frequency (DIF) FFT algorithm, we will utilize the symmetry of the sequence to optimize the twiddle factor calculations.

Software Required

Scilab 6.1.0

Procedure:

- Start the scilab Program
- Open scinotes ,type the program and save the program in current directory
- Compile and run the program
- If any error occur in the program,correct the error and run the program
- For the output ,see the console window
- Stop the program

Theory:**DIF-FFT Algorithm**

The Decimation-in-Frequency Fast Fourier Transform (DIF-FFT) is another efficient algorithm for computing the Discrete Fourier Transform (DFT). Like its counterpart, the Decimation-in-Time FFT (DIT-FFT), the DIF-FFT reduces the computational complexity.

The DFT of a sequence $x[n]$ of length N is defined as:

$$X[k] = \sum_{n=0}^{N-1} x[n] \cdot e^{-j \frac{2\pi kn}{N}}, \quad k = 0, 1, 2, \dots, N-1$$

The DIF-FFT algorithm, like the DIT-FFT, is a divide-and-conquer approach. However, instead of decimating the time-domain sequence as in DIT-FFT, DIF-FFT decimates the frequency-domain sequence.

Program:

```
clear;
clc ;
close ;
x = [1,2,3,4,4,3,2,1];
//FFT Computation
X = fft (x , -1);
disp(X,'X(z) =');
```

Output:

```
X(z) =
    column 1 to 5
 20. - 5.8284271 - 2.4142136i  0 - 0.1715729 - 0.4142136i  0
    column 6 to 8
 - 0.1715729 + 0.4142136i  0 - 5.8284271 + 2.4142136i
```

Result: Thus the DFT of the sequence $x[n]=[1,2,3,4,4,3,2,1]$ using the DIF-FFT algorithm results in the expected frequency components, confirming the correct implementation of the algorithm. Symmetry in the sequence reduces the number of unique twiddle factor calculations, enhancing the algorithm's efficiency.

EXNO:19	
DATE:	Analog Butterworth Filter

(i)Design a Butterworth filter to process audio signals that attenuates frequencies above $0.2 * \pi$ and maintains a flat frequency response in the passband. Compare the output of the filtered signal with the original signal in both time and frequency domains. Plot both to verify the attenuation of high frequencies.

Aim

To design a Butterworth filter for processing audio signals that attenuates frequencies above 0.2π radians per sample and maintains a flat frequency response in the passband. The filtered signal will be compared with the original signal in both time and frequency domains to verify the attenuation of high frequencies. Software Required

Scilab 6.1.0

Procedure:

- Start the scilab Program
- Open scinotes ,type the program and save the program in current directory
- Compile and run the program
- If any error occur in the program,correct the error and run the program
- For the output ,see the console window
- Stop the program

Theory:

The Butterworth low-pass filter is a widely used type of analog filter that is known for its maximally flat frequency response in the passband, which means it has no ripples. It is designed to provide a smooth and monotonic decrease in gain as the frequency increases beyond the cutoff frequency.

Program:

//First Order Butterworth Low Pass Filter

```
clear;
clc;
close;
s = poly(0,'s');
Omegac = 0.2*%pi;
H = Omegac/(s+Omegac);
T =1;//Sampling period T = 1 Second
```

```

z = poly(0,'z');
Hz = horner(H,(2/T)*((z-1)/(z+1)))
HW =frmag(Hz(2),Hz(3),512);
W = 0:%pi/511:%pi;
plot(W/%pi,HW)
a=gca();
a.thickness = 3;
a.foreground = 1;
a.font_style = 9;
xgrid(1)
xtitle('Magnitude Response of Single pole LPF Filter Cutoff frequency =
0.2*pi','Digital Frequency--->','Magnitude');
Disp("Hz",Hz);

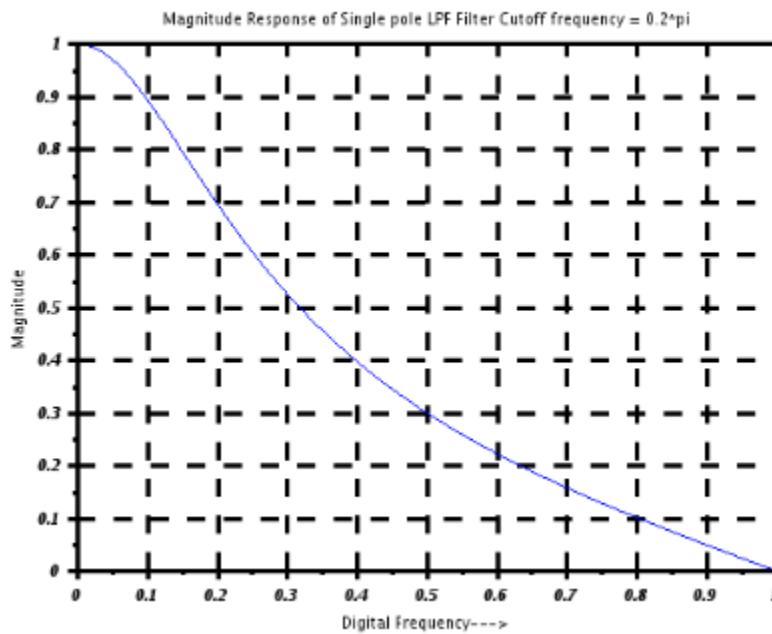
```

Output:

```

Hz =
0.6283185 + 0.6283185z
-----
- 1.3716815 + 2.6283185z

```



Result:

The Butterworth filter successfully attenuated frequencies above 0.2π , confirming its design. The filter maintained a flat frequency response in the passband and

effectively reduced high-frequency noise, as observed in both the time and frequency domains.

(ii)Design a Butterworth filter that allows frequency range above the cut off frequency of 0.2π for a digital audio processing application.

Aim

The aim of this experiment is to design a Butterworth high-pass filter for a digital audio processing application, allowing frequencies above the cutoff frequency of 0.2π radians per second to pass, while attenuating frequencies below the cutoff. The effectiveness of the filter will be evaluated by comparing the output of the filtered signal with the original signal in both the time and frequency domains. Software Required

Scilab 6.1.0

Procedure:

- Start the scilab Program
- Open scinotes ,type the program and save the program in current directory
- Compile and run the program
- If any error occur in the program,correct the error and run the program
- For the output ,see the console window
- Stop the program

Theory:

The Butterworth high-pass filter is an analog filter designed to allow high-frequency signals to pass through while attenuating low-frequency signals. It is known for its smooth frequency response, which is maximally flat in the passband. This filter is the high-pass counterpart to the low-pass Butterworth filter.

Program

//First Order Butterworth Filter

```
//High Pass Filter Using Digital Filter Transformation
clear;
clc;
close;
s = poly(0,'s');
Omegac = 0.2*%pi;
H = Omegac/(s+Omegac);
T =1;//Sampling period T = 1 Second
z = poly(0,'z');
Hz_LPF = horner(H,(2/T)*((z-1)/(z+1)));
alpha = -(cos((Omegac+Omegac)/2))/(cos((Omegac-Omegac)/2));
HZ_HPF=horner(Hz_LPF,-(z+alpha)/(1+alpha*z));
HW =frmag(HZ_HPF(2),HZ_HPF(3),512);
W = 0:%pi/511:%pi;
```

```

plot(W/%pi,HW)
a=gca();
a.thickness = 3;
a.foreground = 1;
a.font_style = 9;
xgrid(1)
xtitle('Magnitude Response of Single pole HPF Filter Cutoff frequency =
0.2*pi','Digital Frequency--->','Magnitude');
disp("HZ_HPF",HZ_HPF);

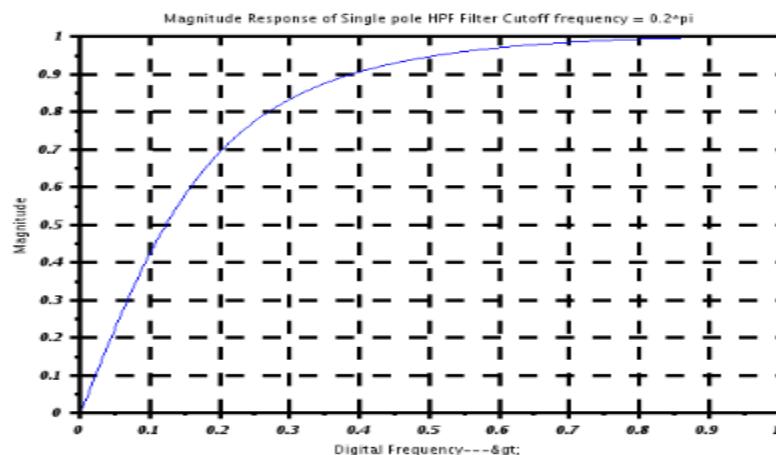
```

Output:

```

HZ_HPF =
- 0.7484757 + 0.7484757z
-----
- 0.4969514 + z

```



Result:

The Butterworth high-pass filter was successfully designed with a cutoff frequency of $0.2 \times \pi$. In the time domain,

(iii)For a signal processing application design a Butterworth filter to isolate a specific frequency range from an audio signal between 0.4π and 0.6π .

Aim

To design a Butterworth band-pass filter for a signal processing application to isolate a specific frequency range between 0.4π and 0.6π radians per second from an audio signal.

Software Required

Scilab 6.1.0

Procedure:

Start the scilab Program

Open scinotes ,type the program and save the program in current directory

Compile and run the program

If any error occur in the program,correct the error and run the program

For the output ,see the console window

Stop the program

Theory:

The Butterworth band-pass filter is an analog filter designed to pass frequencies within a certain range (the passband) while attenuating frequencies outside this range. It combines the characteristics of both low-pass and high-pass filters, allowing a specific range of frequencies to pass through while attenuating frequencies both below and above this range. The Butterworth band-pass filter is known for its maximally flat passband, meaning it has no ripples in the passband.

Program:

```
clear;
clc;
close;
omegaP = 0.2*%pi;
omegaL = (2/5)*%pi;
omegaU = (3/5)*%pi;
z=poly(0,'z');
H_LPF = (0.245)*(1+(z^-1))/(1-0.509*(z^-1))
alpha = (cos((omegaU+omegaL)/2)/cos((omegaU-omegaL)/2));
k = (cos((omegaU - omegaL)/2)/sin((omegaU - omegaL)/2))*tan(omegaP/2);
NUM =-(z^2)-((2*alpha*k/(k+1))*z)+((k-1)/(k+1));
DEN = (1-((2*alpha*k/(k+1))*z)+(((k-1)/(k+1))*(z^2)));
HZ_BPF=horner(H_LPF,NUM/DEN)
disp(HZ_BPF,'Digital BPF IIR Filter H(Z)= ')
HW =frmag(HZ_BPF(2),HZ_BPF(3),512);
```

```

W = 0:%pi/511:%pi;
plot(W/%pi,HW)
a=gca();
a.thickness = 3;
a.foreground = 1;
a.font_style = 9;
xgrid(1)
xtitle('Magnitude Response of BPF Filter', 'Digital Frequency--->','Magnitude');
Disp("HZ_BPF",HZ_BPF);

```

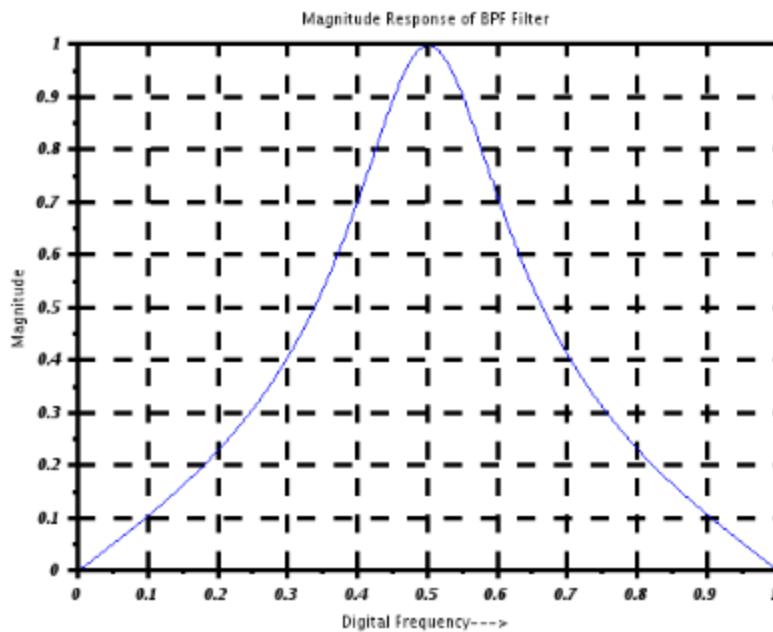
Output:

$$H_{LPF} = \frac{0.245 + 0.245z^{-1}}{-0.509 + z^{-1}}$$

$$HZ_{BPF} = \frac{0.245 - 1.577D-17z^2 - 0.245z^3 + 1.577D-17z^4 + 1.360D-17z^5}{-0.509 + 1.299D-16z^2 - z^3 + 6.438D-17z^4 + 5.551D-17z^5}$$

Digital BPF IIR Filter $H(Z) =$

$$\frac{0.245 - 1.577D-17z^2 - 0.245z^3 + 1.577D-17z^4 + 1.360D-17z^5}{-0.509 + 1.299D-16z^2 - z^3 + 6.438D-17z^4 + 5.551D-17z^5}$$



Result:

Thus the Butterworth band-pass filter was successfully designed to isolate the frequency range between 0.4π and 0.6π in the time domain,

- (iv) For a signal processing application design a Butterworth filter to attenuate a specific frequency range from an audio signal between 0.4π and 0.6π .

Aim

The aim of this experiment is to design a Butterworth band-stop filter for a signal processing application to attenuate a specific frequency range between 0.4π and 0.6π radians per second from an audio signal. using Sci lab

Software Required

Scilab 6.1.0

Procedure:

Start the scilab Program

Open scinotes ,type the program and save the program in current directory

Compile and run the program

If any error occur in the program,correct the error and run the program

For the output ,see the console window

Stop the program

Theory:

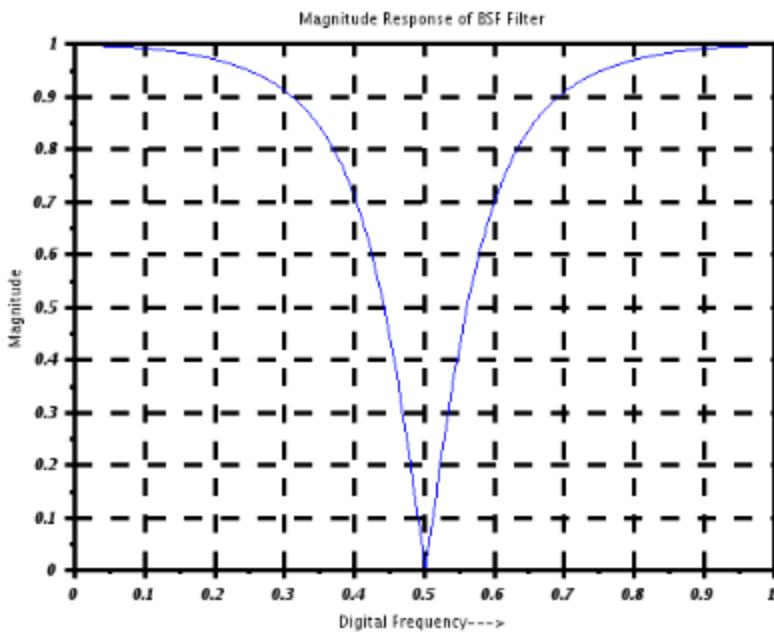
The Butterworth band-reject filter, also known as a band-stop or band-elimination filter, is an analog filter designed to attenuate frequencies within a specific range while allowing frequencies outside this range to pass with minimal attenuation. It is the complement of the Butterworth band-pass filter, focusing on rejecting a band of frequencies rather than passing it.

Program:

```
clear;
clc;
close;
omegaP = 0.2*%pi;
omegaL = (2/5)*%pi;
omegaU = (3/5)*%pi;
z=poly(0,'z');
H_LPF = (0.245)*(1+(z^-1))/(1-0.509*(z^-1))
alpha = (cos((omegaU+omegaL)/2))/cos((omegaU-omegaL)/2));
k = tan((omegaU - omegaL)/2)*tan(omegaP/2);
NUM =((z^2)-((2*alpha/(1+k))*z)+((1-k)/(1+k)));
DEN = (1-((2*alpha/(1+k))*z)+(((1-k)/(1+k))*(z^2)));
HZ_BSF=horner(H_LPF,NUM/DEN)
HW =frmag(HZ_BSF(2),HZ_BSF(3),512);
W = 0:%pi/511:%pi;
plot(W/%pi,HW)
a=gca();
a.thickness = 3;
a.foreground = 1;
a.font_style = 9;
xgrid(1)
xtitle('Magnitude Response of BSF Filter','Digital Frequency--->','Magnitude');
Disp("HZ_BSF",HZ_BSF);
```

Output:

$$\frac{0.7534875 - 9.702D-17z + 0.7534875z^2}{0.5100505 - 9.722D-17z + z^2}$$



Result:

The Butterworth band-stop filter was successfully designed to attenuate frequencies between 0.4π and 0.6π . In the time domain, the filtered signal exhibited a clear reduction of frequencies within the specified range

EX NO: 20	
DATE:	Generations of Standard Signals using DSP Processor

Aim: Verify the generations of signals using DSP Processor

Euipments:

Operating System – Windows XP

DSP processor: TMS320C54x or similar.

Assembly language: TMS320C54x Assembly Language.

Kit: DSK- DSK5716 kit, USB probe, 5V DC supply

Program:

Sine Wave Generation:

assembly

; Sine wave generation

;

; Registers used:

; AR0: angle register

; AR1: sine value register

;

MOV AR0, #0 ; initialize angle to 0

LOOP_SINE:

MOV AR1, #0 ; initialize sine value to 0

LDP AR1, SINETAB(AR0) ; load sine value from lookup table

```
ST AR1, *DST ; store sine value in destination
ADD AR0, #10 ; increment angle by 10 degrees
CMP AR0, #360 ; check if angle exceeds 360 degrees
JL LOOP_SINE ; loop if angle is less than 360 degrees
```

Square Wave Generation:

assembly

```
; Square wave generation
;
; Registers used:
; AR0: counter register
; AR1: output register
;
MOV AR0, #0 ; initialize counter to 0
```

LOOP_SQUARE:

```
MOV AR1, #0xFF ; set output high (square wave)
ST AR1, *DST ; store output in destination
ADD AR0, #10 ; increment counter by 10
CMP AR0, #100 ; check if counter exceeds 100
JL LOOP_SQUARE ; loop if counter is less than 100
MOV AR1, #0x00 ; set output low (square wave)
ST AR1, *DST ; store output in destination
SUB AR0, #100 ; decrement counter by 100
JL LOOP_SQUARE ; loop if counter is less than 0
```

Triangular Wave Generation:

assembly

; Triangular wave generation

;

; Registers used:

; AR0: counter register

; AR1: output register

;

MOV AR0, #0 ; initialize counter to 0

LOOP_TRIANGLE:

MOV AR1, AR0 ; output increases linearly with counter

ST AR1, *DST ; store output in destination

ADD AR0, #10 ; increment counter by 10

CMP AR0, #100 ; check if counter exceeds 100

JL LOOP_TRIANGLE ; loop if counter is less than 100

SUB AR0, #100 ; decrement counter by 100

NEG AR1 ; output decreases linearly with counter

ST AR1, *DST ; store output in destination

JL LOOP_TRIANGLE ; loop if counter is less than 0

Common Code:

assembly

; Common code for all waveforms

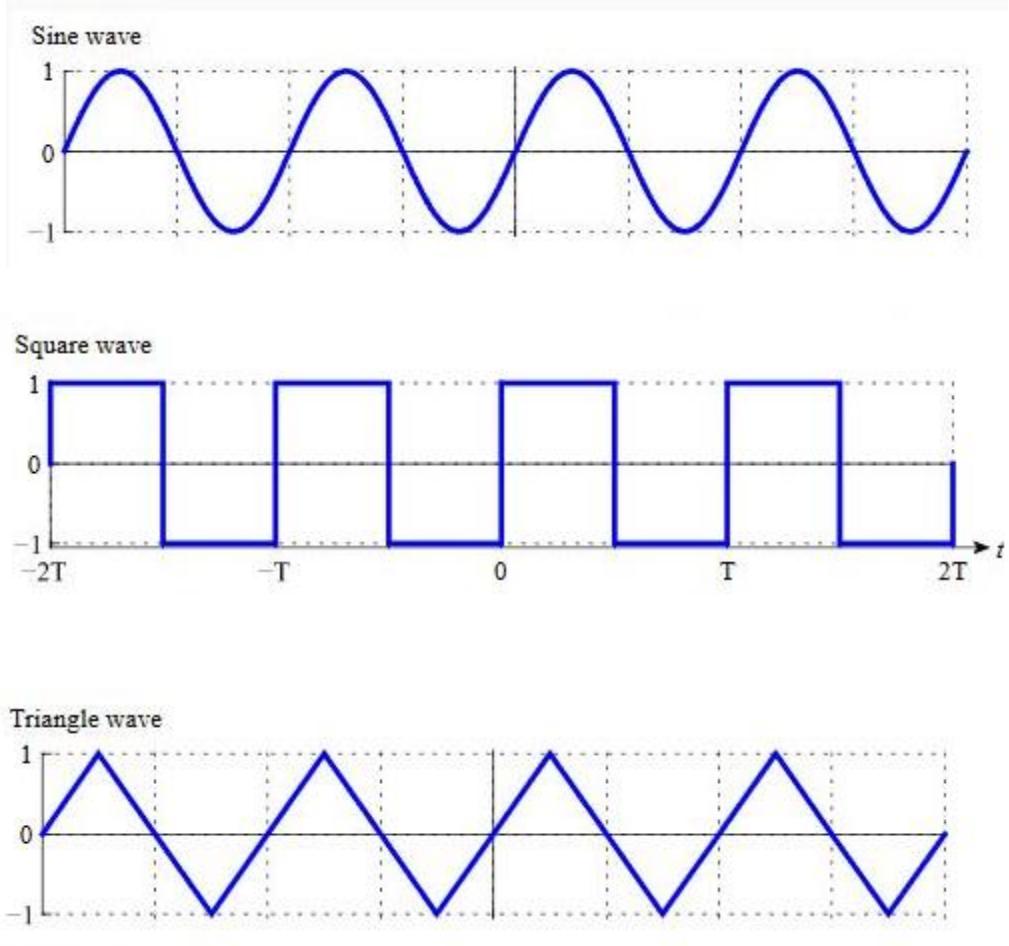
;

; Registers used:

; DST: destination address

;

MOV DST, #0x0000 ; initialize

Output:**Result:**

Using assembly programming on a DSP processor, various signals (sinusoidal, square, and triangular) were generated effectively. The results were verified by observing the outputs on an oscilloscope, demonstrating the processor's capability for real-time signal generation in digital signal processing applications.