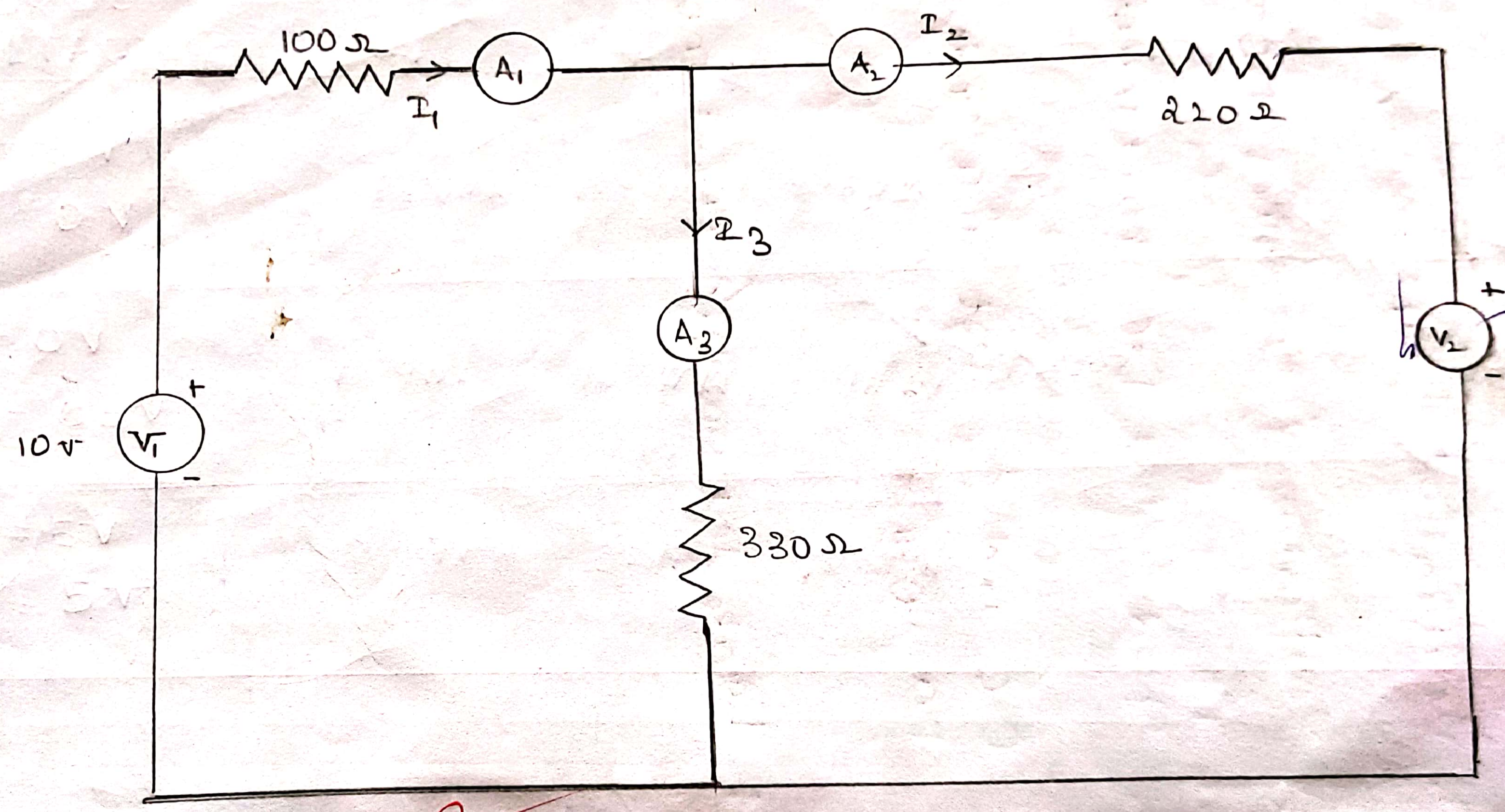
CIRCUIT DIAGRAM



Experiment-I Super Position Theorem

Aim: To Verify superposition Theorem

Apparatus: 1. Physitechs superposition Theorem trainer kit

2. Milli Ammeter (0-20mA)

3. connecting wires

Procedure:

1. Switch on the Physitechs superposition theorem trainer kit.

2. In trainer two power supplies are present one is variable (0-12V) and another is fixed 5V.

3. Connect the 0-12V supply to V_1 and 5V supply to V_2 terminal

4. Connect three milli ammeters to I_1, I_2, I_3

5. Note down the three current values, when the two supplies are connected.

6. Short the supply V_2 and note down corresponding I_1, I_2 and I_3 readings due to voltage source V_1

7. Verify the superposition theorem by using form...

SOURCE VOLTAGES	Theoretical			Pratical		
	I_1	I_2	I_3	I_1	I_2	I_3
$V_1 = 5\,V$, $V_2 = 0\,V$	-21.6mA	12.9mA	8.6mA	20.9	12.79	8.53
$V_1 = 0\,V$, $V_2 = 5\,V$	12.9mA	16.8mA	3.9mA	12.6	16.64	3.79
$V_1 = 5\,V$, $V_2 = 5\,V$	8.7mA	3.9mA	12.5mA	8.3	3.87	12.39

8. Repeat the same procedure for another values of voltage (for ex: 5V, 8V, 12V).

Calculation:-

$$\frac{x-5}{100}+\frac{x-0}{220}+\frac{x-0}{330}=0 \Rightarrow \frac{x-5}{100}=-\left(\frac{330x+220x}{330\times 200}\right)$$

$$\frac{5-x}{10}=\frac{550}{33\times 22}x \qquad I_1=\frac{x-5}{100} \Rightarrow \frac{2.84-5}{100}$$

$$5-x=\frac{25x}{33} \qquad = \ominus 21.6\,mA$$

$$\Rightarrow \frac{33\times 5}{58}=x$$

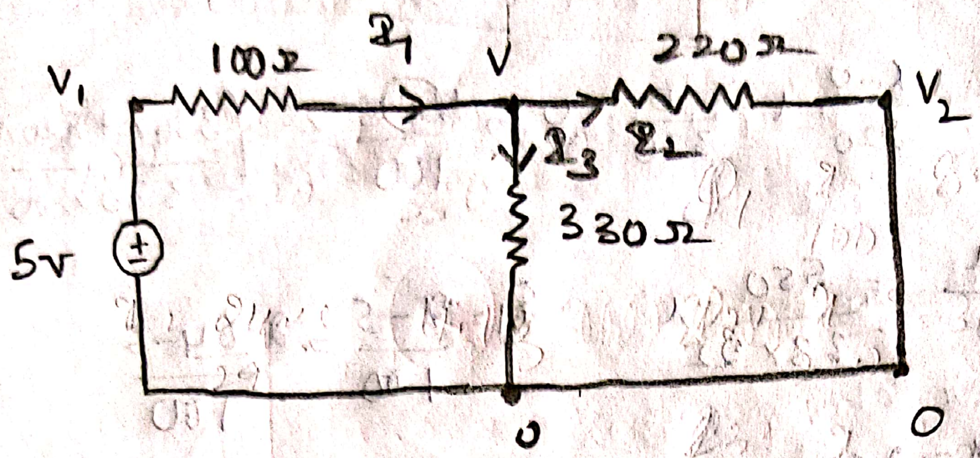
$$x=2.84$$

15

Result:- Superposition theorem is verified practically and theoretically.

Case ①: when $V_1 = 5V$

$V_2 = 0V$



$I_1 = I_3 + I_2$ $\qquad V_2 = 0$

$$\frac{V_1 - 5}{100} = \frac{V}{330} + \frac{V - V_2}{220}$$

$$\frac{V_1 - 5}{10} = \frac{V}{33} + \frac{V - V_2}{22}$$

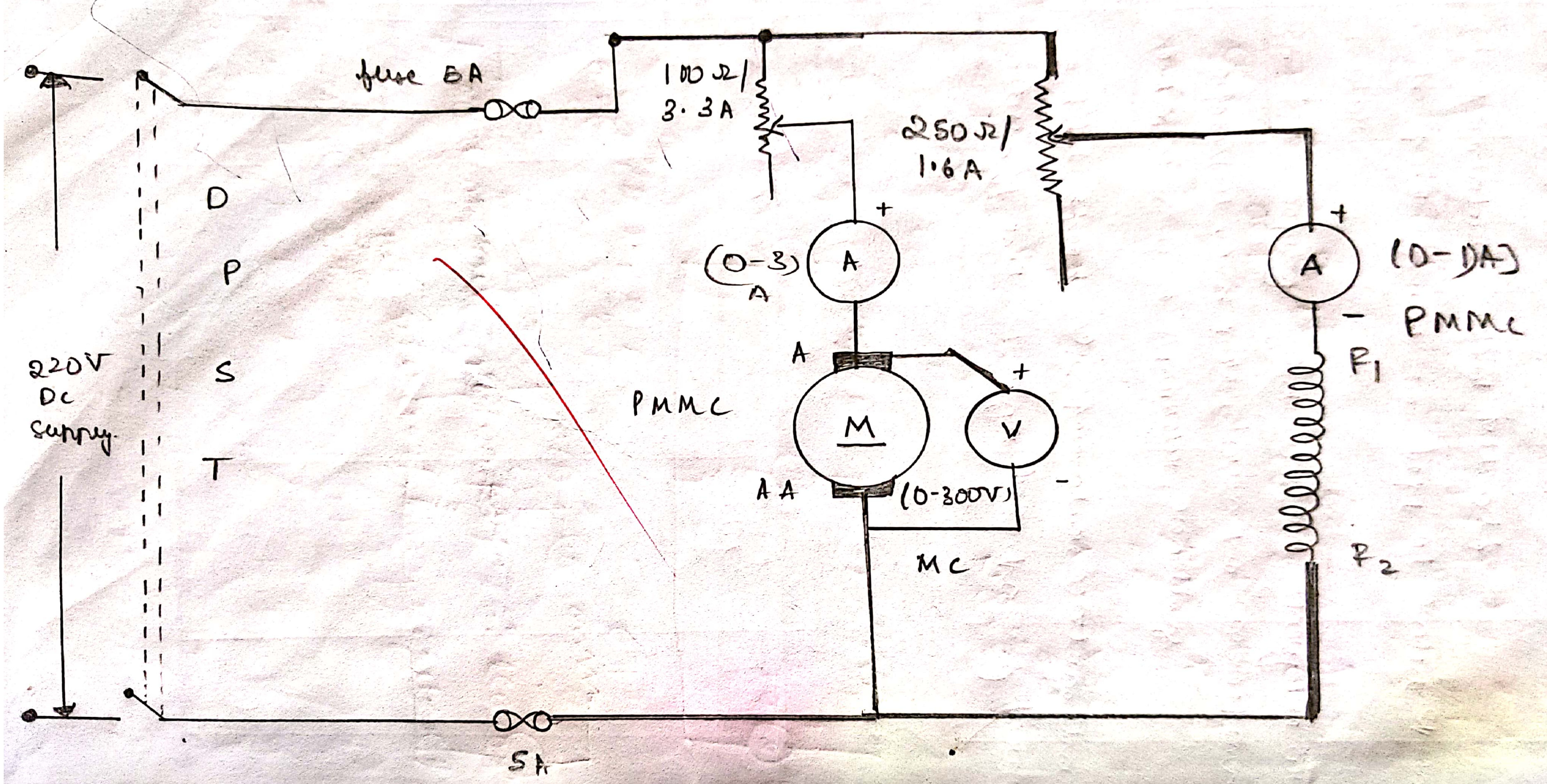
$$\frac{V_1 - 5}{10} = \frac{V}{33} + \frac{V}{22}$$

$$\frac{11V_1 - 55}{165} = \frac{2V + 3V}{\cancel{6}\ 3}$$

$$25V = 33V_1 - 165$$

$55 \times 3 = 165$

Circuit Diagram for speed control on DC shunt machine



Experiment - II Speed Control of DC Shunt Motor

Aim:- To control the speed of the DC shunt motor (i): Armature control and (ii): Field flux control.

~~Procedure~~

Apparatus Required:-

S.NO	Name of the APP	Type	Range	Quantity
1	Ammeter	PMMC	(0-3)A (0-1)A	1 1
2	Voltmeter	PMMC	0-300V	1
3	Rheostat	Wire wound	250Ω/1.6A 100Ω/3.3A	1 1
4	Tachometer	Digital	(0-9999) RPM	1
5	Fuse	TCC	5A	2
6	Connecting wires	-	-	Required

Procedure:- 1. Connect the apparatus as per the circuit diagram.

2. Switch on the power supply and close the DPST switch

3. Initially the field rheostat should be min-

observations:-

Armature control:

S.NO	Armature Current (A)	Speed N (RPM)	Field current (A)	Armature voltage (V)
1	0.82×2 = 1.64	1500	0.55	216
2	0.8×2 = 1.60	1400	0.55	200
3	0.8×2 = 1.60	1300	0.55	190
4	0.77×2 = 1.54	1200	0.55	174
5	0.75×2 = 1.5	1100	0.55	160
6	0.75×2 = 1.5	1000	0.55	150
7	0.75×2 = 1.5	900	0.55	134

Field Flux control:

S.NO	Armature Current (A)	Speed N (RPM)	Field Current	Armature voltage (V)
1	0.83×2 = 1.64	1500	0.55	216
2	0.84×2 = 1.60	1550	0.52	216
3	0.85×2 = 1.7	1600	0.50	216
4	0.85×2 = 1.7	1650	0.48	216
5	0.85×2 = 1.7	1700	0.45	216.

4. Adjust field resistance of motor to increase the speed to the rated speed.

(i):- Armature Control Method:

1. Speed should be kept at rated speed of the motor.

2. By keeping field constant vary the armature rheostat and note down the corresponding voltmeter and Ammeter readings.

3. Plot speed v/s Armature voltage characteristics. It is a straight lines passing through origin.

(ii):- Field Control Method:-

1. Speed should be kept at rated speed.

2. By keeping armature voltage constant, field is varied and corresponding voltmeter and ammeter readings are noted.

3. Plot Speed v/s Field current characteristics. It is a rectangular hyperbola.

Precautions:- 1. Before the supply is turned on, the field rheostat should be at minimum position and armature rheostat at maximum resistance position.

2. Avoid loose connections

3. Avoid parallax error while nothing the readings from the meter.

Results: Speed below rated speed can be obtained through armature voltage control & speed above rated speed using field control method.

15

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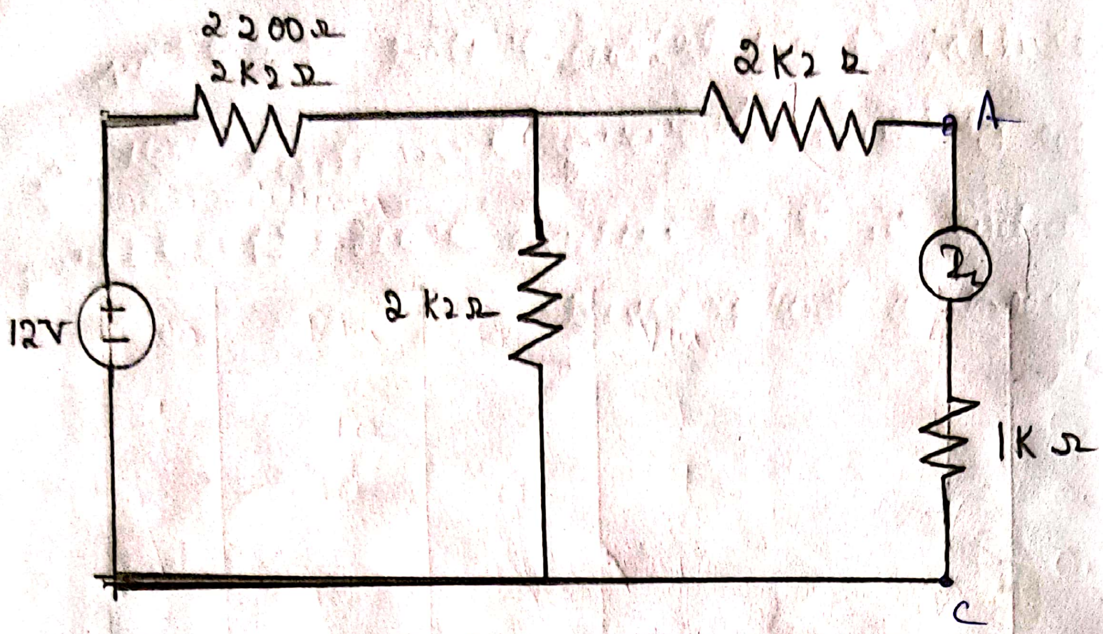
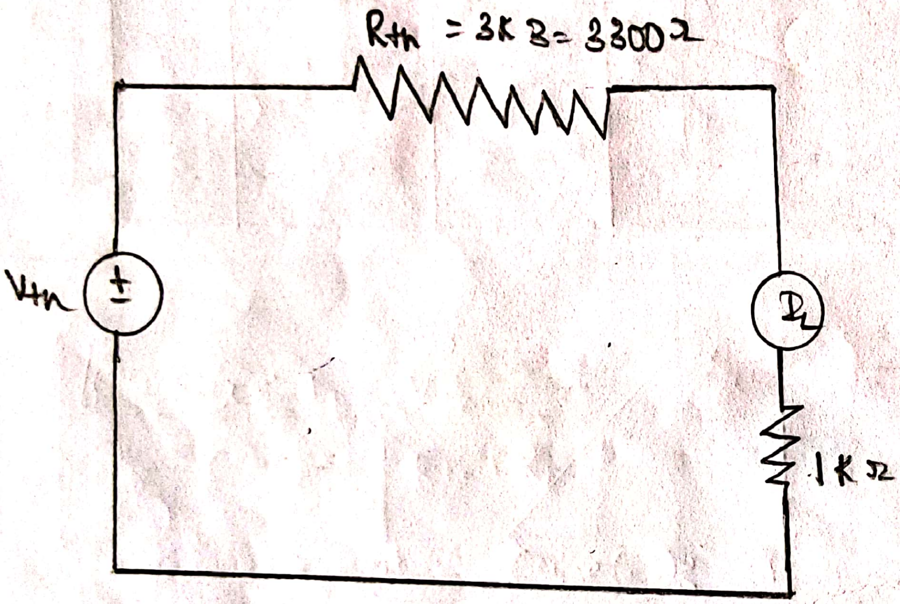


2200Ω
2K2Ω
2K2Ω
A
12V
2K2Ω
D1
1KΩ
C



Rth = 3K3 = 3300Ω
Vth
D1
1KΩ

Experiment-III Thevenins Theorem

Aim: To verify the Thevenins Theorem.

Apparatus: 1. Physitechs Thevenins Theorem trainer kit

2. Milli Ammeter (0-20mA)
3. Voltmeter
4. Connecting wires.

Procedure:-

1. Switch on the Physitechs Thevenins theorem trainer kit.
2. Connect the 0-12V supply to the V terminal
3. connect millie ammeter to the I_1 terminal i.e., across A, B.
4. Note down the ammeter reading.
5. Connect the voltmeter across A and C termina
6. Note down the reading of V_{Th}
7. Connect the V_{th} supply to V_{th} terminal of thevenins equivalent circuit.
8. Connect Mille Ammeter to the I_L terminal i.e, across A, B of equivalent circuit.
9. Note down the ammeter reading
10. Compare the I_L value of both the circuits.
11. Calculated theoretically by using the formula given below

Tabular Column

S.NO	R_{th}	R_L	V_{th}	I_L
1	10	5	12	0.80
2	10	10	12	0.60
3	10	15	12	0.48
4	10	20	12	0.40
5	10	25	12	0.34

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

Case ①:-

$I_L = \frac{12}{10+5}$

$= 0.80\,A$

Case ②:- $\frac{12}{10+10}$

$\frac{12}{20}$

$0.60\,A$

Case ③:- $I_L = \frac{12}{10+15}$

$I_L = 0.48\,A$

Case ④:- $\frac{12}{30} = I_L$

$I_L = 0.40\,A$

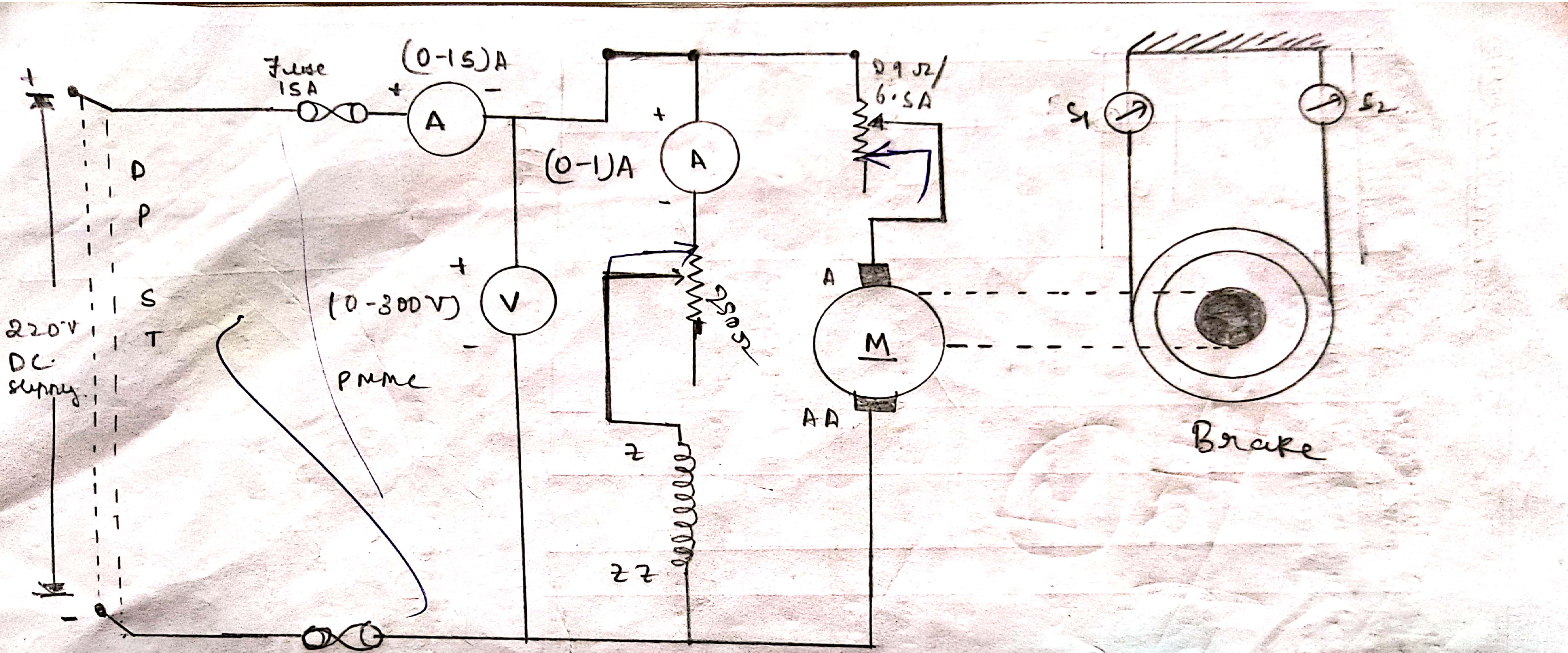
Case ⑤:- $I_L = \frac{12}{10+25}$

$I_L = 0.34\,A$

Result: Hence thevenins theorem is verified theoretically and practically

22/4/25

15



Circuit Diagram.
Brake test on DC shunt motor

S.NO	Voltage (Volts)	Current (I) (A)	Speed	Spring Balance S1	Spring Balance S2	Spring Balance S3 ($S_1 \sim S_2$)	Value	Output $2\pi NT/60$	Input	% η = OP/IP
1.	103×2=206	1.3 A	1560	0	0	0	0	0	267.8	0
2.	104×2=208	2.5 A	1484	0		1	0.7848	121.96	520	23.4%
3.	104×2=208	3.45 A	1470	0	2	2	1.5696	241.62	780	30.9%
4.	103×2=206	5.00	1468	0	3	3	2.34	359.29	1030	34.8%
5.	102×2=204	6.28	1455	0	3.5	3.5	2.3544	359.96	1278	28.1%
6	102×2=204	7.80	1446	1	4	3	3.1392	475.35	1530	31.7%

(4)

that the motor runs at its rated speed.

6. Note down the readings of ammeter, voltmeter and tachometer for different values of load.

7. Continue the experiment till full load (rated current) of the motor is reached.

8. Remove the load on the pulley and switch off the supply.

9. Tabulate the observations and plot the required graphs.

Precautions:

1. The motor field rheostat should be kept at minimum resistance position, armature rheostat should be at maximum position.

2. At the time of starting, the motor should be in no load condition.

3. Cool the pulley by using water while the experiment is performed.

4. While measuring the radius of the pulley effective radius must be considered.

5. Reading should be taken without parallax errors.

6. Avoid loose connections.

Result: $\eta_{max} = 64\%$, $T_{max} = 8.11\,Nm$

By performing brake test on DC shunt motor efficiency ... torque of 8.11Nm is obtained

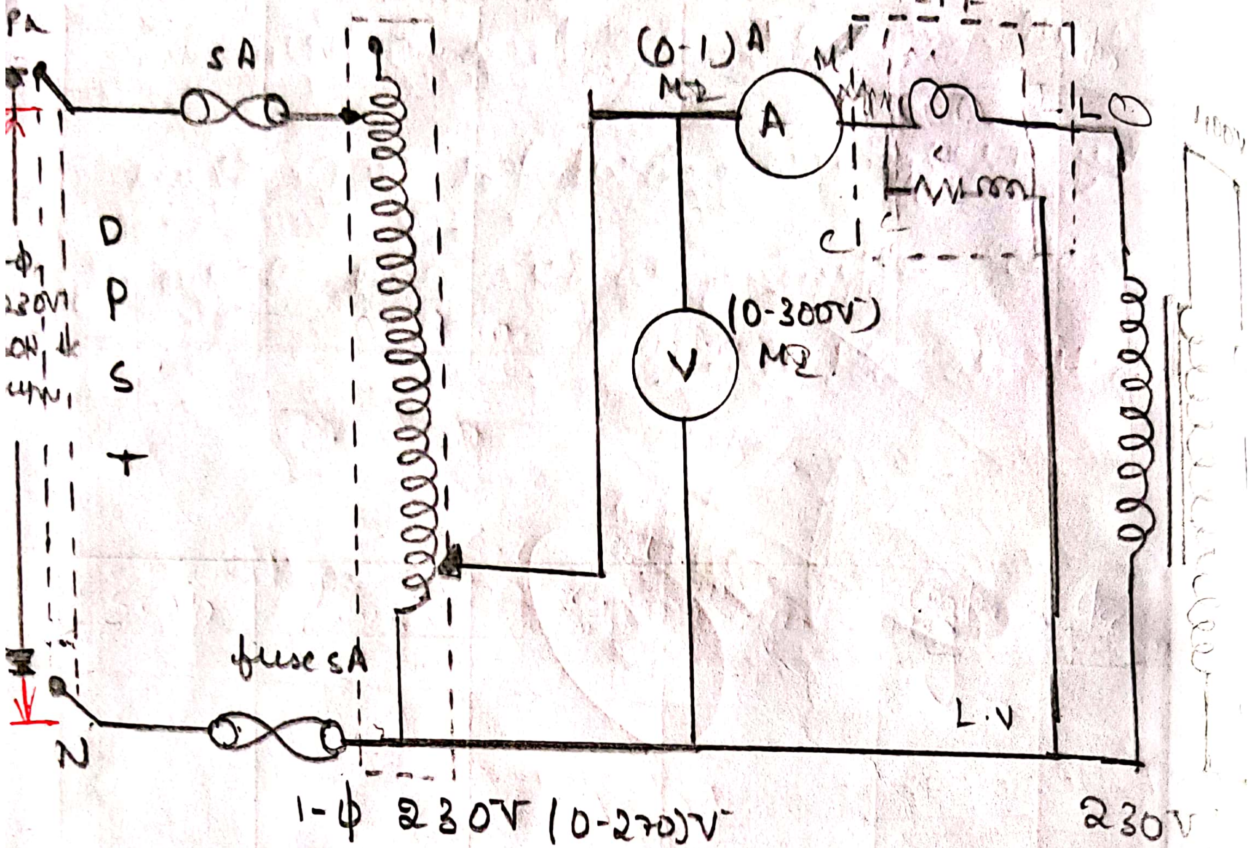
Result:- $\eta = 64\%$ and $T_{max} = 8.11 Nm$

By performing brake test on DC shunt motor efficiency is 64% and torque of 8.11 is obtained

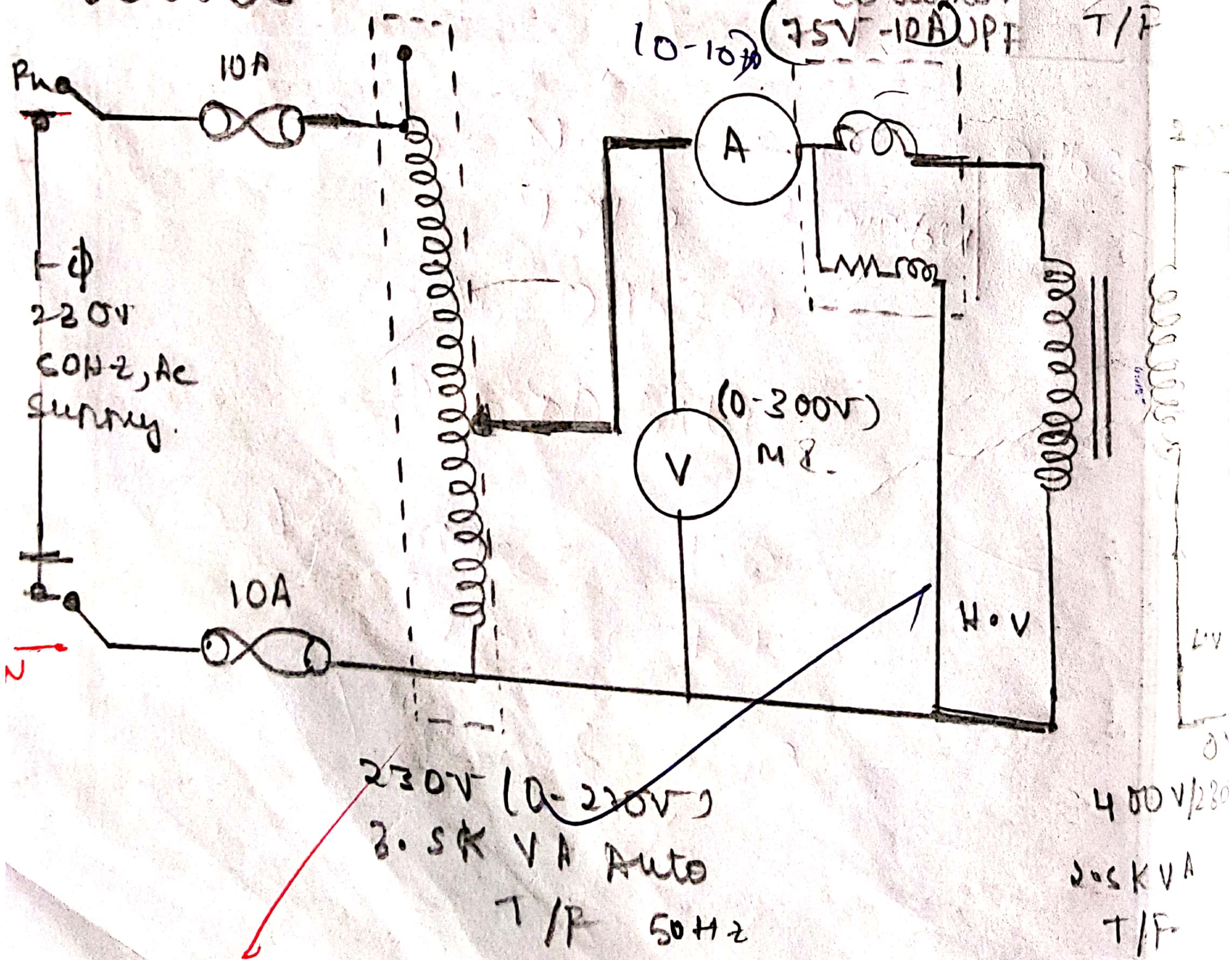
22/4/24

18

Open Circuit



Short circuit



Circuit Diagram

8/3

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Experiment-V Open Circuit and Short Circuit test on a single phase transformer

Aim:- To perform open circuit and short circuit test on a single phase transformer and to find efficiency and regulation at different power factors.

Apparatus Required:-

S.No	Apparatus	Type	Range	Quantity
1	Variac	1-ϕ	1-ϕ, 230V/0-270V 50Hz	1
2	Transformer	1-ϕ	(230/400)V/2.5KVA, 50Hz	1
3	wattmeter	LPF	300 V/2.5A	1
4	Ammeter	MI	(0-1)A	1
5	Ammeter	MI	(0-10)A	1
6	wattmeter	UPF	75/10 Ω	1
7	Fuse	TCC	(0-10) A	1
8	Switch	DSPT	(0-30) A	1
9	voltmeter	MI MI	0-300V 0-75V	1
10	connecting wires			Required

Procedure:- Open circuit test:-

1. Connect the apparatus as per the circuit diagram
2. Apply the rated voltage to L.V windings using an auto-transformer.
3. Note down the readings of ammeter, voltmeter and wattmeter.

$\cos\phi$	fraction load (x)	load current $x * I_{sc}$	O/P Power $x * KVA * \cos\phi$	Iron losses	Cu losses $x^2 * W$	total losses (W)	% η
	1/4	1/4 × 6.25 = 1.5625	1/4 × 2500 × 0.5 = 312.5	6	$\frac{1}{16}$ × 110 = 6.875	6 + 6.875 = 12.875	96.04%
0.5	1/2	1/2 × 6.25 = 3.125	1/2 × 2500 × 0.5 = 625	6	$(\frac{1}{2})^2$ × 110 = 27.5	6 + 27.5 = 33.5	94.91%
	3/4	3/4 × 6.25 = 4.6875	3/4 × 2500 × 0.5 = 937.5	6	$(\frac{3}{4})^2$ × 110 = 61.875	6 + 61.875 = 67.875	93.24%
	1	1 × 6.25 = 6.25	1 × 2560 × 0.5 = 1280	6	$(1)^2$ × 110 = 110	6 + 110 = 116	91.50%

Calculation:-

$$\eta = \frac{O/P}{O/P + losses} = \frac{312.5}{312.5 + 12.85} \times 100 = 0.96043 \times 100 = 96.043\%$$

$$\eta = \frac{625}{625 + 33.5} \times 100 = 0.94912 \times 100 = 94.912\%$$

$$\eta = \frac{937.5}{937.5 + 67.875} \times 100 = 0.93248 \times 100 = 93.248\%$$

$$\eta = \frac{1280}{1280 + 116} \times 100 = 0.9150 \times 100 = 91.508\%$$

Formulas:-

$W_0 = V_0 * I_0 * \cos\phi_0$

$\cos\phi = W_0/(V_0 * I_0)$

$W_{SC} = I_{SC}^2 * R_{02}$

$R_{02} = W_{SC}/I_{SC}^2$

$Z_{02} = V_{SC}/I_{SC}$

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

Voltage Regulation $= I_{SC} * (R_{02} * \cos\phi_2 + X_{02} * \sin\phi_2)/V_{02}$

SC test:- $W_{SC} = V_{SC} \times I_{SC} \times \cos\phi_{SC}$

$R_{02} = \frac{W_{SC}}{I_{SC}^2} = \frac{110}{6.25 \times 6.25}$ $R_{02} = 2.816\,\Omega$

$Z_{02} = \frac{V_{SC}}{I_{SC}} = \frac{29}{6.25} = 4.64$

$X_{02} = \sqrt{Z_{02}^2 - R_{02}^2} = 21.5296 - 4.77$ $X_{02} = 4.029.$

$X_{02} = 3.6877$

$\% R\ lag = \frac{6.25((2.816)\times(0.3) + (3.6877)(0.95))\times 100}{29}$

$= 93.70\%$

$load = \frac{6.25 * (2.816\ (0.3) - (3.6877)(0.95))}{29}$

$= 57.29\%$

O.C test:- $\cos\phi_2 = 0.5$, $\sin\phi_2 = 0.866$

$lag\ \% R = \frac{6.25((2.816)(0.5) + (3.6877)(0.866))\times 100}{29}$

$= 99.159\%$

$lead\ \% R = \frac{6.25(2.816)(0.5) - (3.6877)(0.866))\times 100}{29}$

$= 38.46\%$

O.C test:

S.NO	V_0 (volts)	I_0 (amps)	W_0 (watts)	$\cos\phi_0$	ϕ_0
1	230	0.64	6×4 = 24	0.16304	1.407

Cal:- $\cos\phi_0 = \frac{W_0}{V_0 I_0} = \frac{24}{230 \times 0.64} = 0.16304$

$\cos\phi_0 = 0.16304$

$\phi_0 = 1.407°$

S.NO	V_{sc} (volts)	I_{sc} (Amps)	W_{sc} (watts)	$\cos\phi_{sc}$	ϕ_{sc}
1	$\frac{58}{2} = 29$	6.25	110	0.606	52.62

Cal:- $\cos\phi_{sc} = \frac{W_{sc}}{V_{sc} I_{sc}} = \frac{110}{181.25}$

$\phi_{sc} = 52.625$

29/03/25. (12)

and wattmeter
4. The wattmeter readings gives the value of core loss as ohmic losses are neglected.

Short circuit test :-
1. Connect the circuit as per the circuit diagram.
2. The L.V side is short circuited
3. Apply rated current to the H.V side using auto transformer (2-12%) of rated voltage.
4. Note down the readings gives the values of the ohmic loss in both the windings are core loss are negligible

Observations :- 1. Tabulate the data obtained calculated the efficiency at different power factors also obtain regulations at different loads.
2. Plot the "efficiency" and "regulation" curves

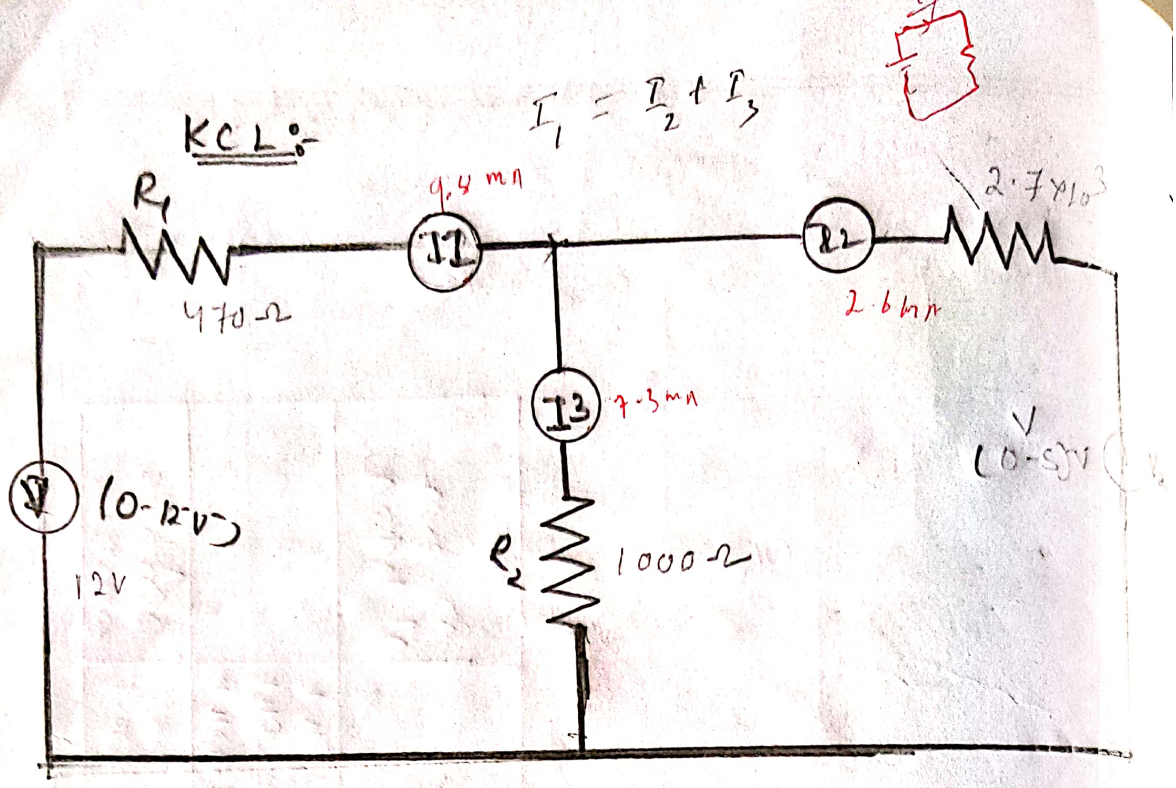
Precautions :- 1. Loose connections should be avoided
2. Readings are taken without parallax error.
3. An L.P.F wattmeter is used for OC test.
4. O.C test should be done on L.V side and SC test on H.V side for convience.

22/4/25 9

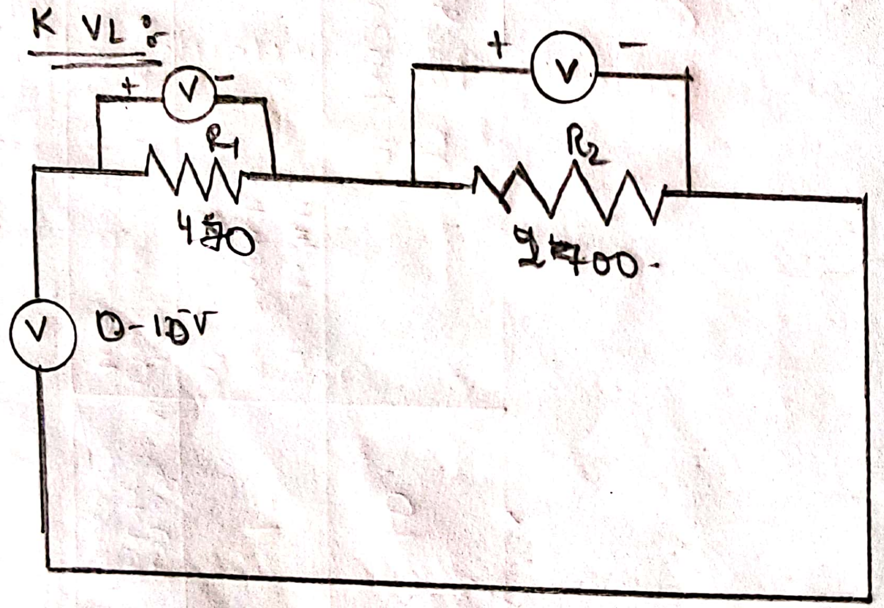
~~Result :- 1. from efficiency curves the transformer obtains highest efficiency~~
Result :- voltage regulation for lead = 93.70%
voltage regulation for lag = 99.159%.

KCL:-

$I_1 = I_2 + I_3$



KVL:-



Kirchhoff's law Experiment - VI

Aim:- To verify the Kirchhoff's Voltage law and Kirchhoff's current law for the given circuit

Apparatus:- 1. Physitechs Kirchhoff's law trainer kit.

2. voltmeter
3. Ammeter
4. Connecting wires

Procedure:- (a):- Kirchhoff's voltage law:-

1. Connect the circuit as shown in fig
2. measure the voltages across the resistors
3. observe that the algebraic sum of voltages in a closed loop is zero.

(b):- Kirchhoff's current law:-

1. Connect the circuit as shown in fig.
2. Measure the currents through the resistors
3. observe that the algebraic sum of the current at a node is zero

Result:- By using KVL and KCL we can also verify whether our measurements are consistent with the laws. If there is a significant difference between the expected value and the measured values. It may be necessary to recheck the circuit connections or the calculations

Circuit config	Resistor values (Ω)	Power supply voltage (V)	Measured current (A)	Measured voltage	Expected current (A)	Expected voltage (V)
Series circuit	$R_1 = 470\,\Omega$ $R_2 = 2.7\times10^3\,\Omega$ $R_3 = 10^3\,\Omega$	12	$i_1 = 7.7$ mA $i_2 = 2.06$ mA $i_3 = 7.7$ mA		$i_1 = 9.48$ mA $i_2 = 2.70$ mA $i_3 = 7.3$ mA	
Parallel circuit	$R_1 = 470\,\Omega$ $R_2 = 2.7\times10^3$	10		$V_1 = 1.48$ V $V_2 = 8.5$ V		$V_1 = 1.48$ V $V_2 = 8.5$ V

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Calculations:-

KCL = $A_1 = A_2 + A_3$

$$\frac{12-V}{470} = \frac{V-5}{2.7\times10^3} + \frac{V}{1000}.$$

$$\frac{12}{470} + \frac{1}{540} = \frac{V}{2.7\times10^3} + \frac{V}{1000} + \frac{V}{470}$$

$$\frac{1}{2700} = 3.7\times10^{-4}, \frac{1}{1000} = 0.001, \frac{1}{470} = 2.12\times10^{-3}$$

$= 0.00037, 0.001, 0.00212.$

$= 0.0255 + 1.85\times10^{-3} = V(3.49\times10^{-3})$

$= 0.0255 + 0.00285 = V(0.00349)$

$V = 7.836V$

$$A_1 = \frac{7.836}{470} = 0.0166A$$

$$A_2 = \frac{7.836}{2.7\times10^3} = 2.902\times10^{-3}$$

$$A_3 = \frac{7.836}{1000} = 0.007836A.$$

13 Recom 8

Apply KVL:-

$V_1 = 470\times i_1, \; V_2 = 2.7\times10^3\times i_2$

$-10 + 470 i_1 + 2.7\times10^3\times i_1 = 0.$

$3170 i_1 = 10$

$$i_1 = \frac{10}{3170} = \frac{1}{317} = 3.15\times10^{-3}.$$

Across the resistor 470Ω.

$V_1 = 470 \times i_1$

$= 470 \times 3.28 \times 10^{-3}$

$V_1 = 1.4805 V$

$= 2.7 \times 10^3 \Omega$

$V_2 = 2.7 \times 10^3 \times i_1$

$= 2.7 \times 10^3 \times 3.15 \times 10^{-3}$

$V_2 = 2.7 \times 3.15 = 8.505 V$.

Result:- Hence Kirchoffs Laws are verified theoretically and pratically