DELHI TECHNOLOGICAL UNIVERSITY

BEE LAB

EXPERIMENT NO 5

TO VERIFY THE TELLENGEN'S THEOREM

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2K20/B17/33

AIM :- *To Verify **Tellegen's Theorem**.*

THEORY :-

According to **Tellegen theorem**, the summation of instantaneous powers for the n number of branches in an electrical network is zero.

In any network the ***algebraic sum of power at any given point is zero.***

We can say that,

Power delivered by some elements = Power absorb by the remaining elements.

Note:

1.) It depends on voltage and current product of an element but not on the type of element.

2.) While verifying Tellegen's theorem do not disturb original network

Suppose there are '**n**' number of branches in an electrical network have i_1, i_2, i_3, ……. i_n respective instantaneous currents through them. These currents satisfy **Kirchhoff's Current Law**.

Again, suppose these branches have instantaneous voltages across them are v_1, v_2, v_3, …….. v_n respectively. If these voltages across these elements satisfy **Kirchhoff Voltage Law** then,

$\mathbf{v_k}$ is the instantaneous voltage across the $\mathbf{k^{th}}$ branch and $\mathbf{i_k}$ is the **instantaneous** current flowing through this branch. **Tellegen theorem** is applicable to lumped networks that consist of ***linear, non-linear, time variant, time-invariant,*** and **active and passive elements.**
Thus, this ***theorem*** **states that:**

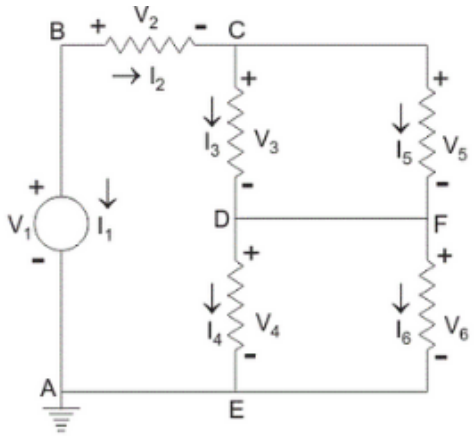
For k^{th} source :-

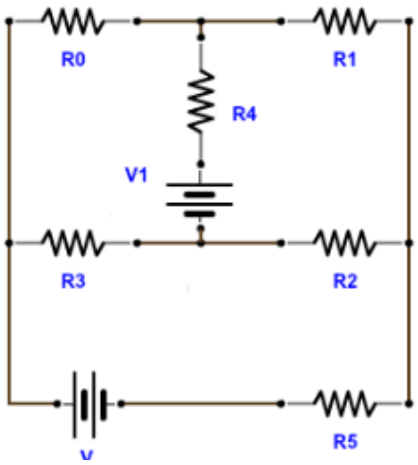
$$\sum_{K=1}^{n} v_K i_K = 0$$

Where ,
n is the number of branches
$\boldsymbol{v_K}$ is the voltage in the branch

$\mathbf{i_K}$ is the current flowing through the branch.

TELLEGEN THEOREM





This theorem can easily be explained by the following example.

Thus, it has been observed that the sum of power delivered to a closed network is zero. This proves the Tellegen's theorem and also proves the conservation of power in any electrical network.

It is also evident that the sum of power delivered to the network by an independent source is equal to the sum of power absorbed by all passive elements of the network.

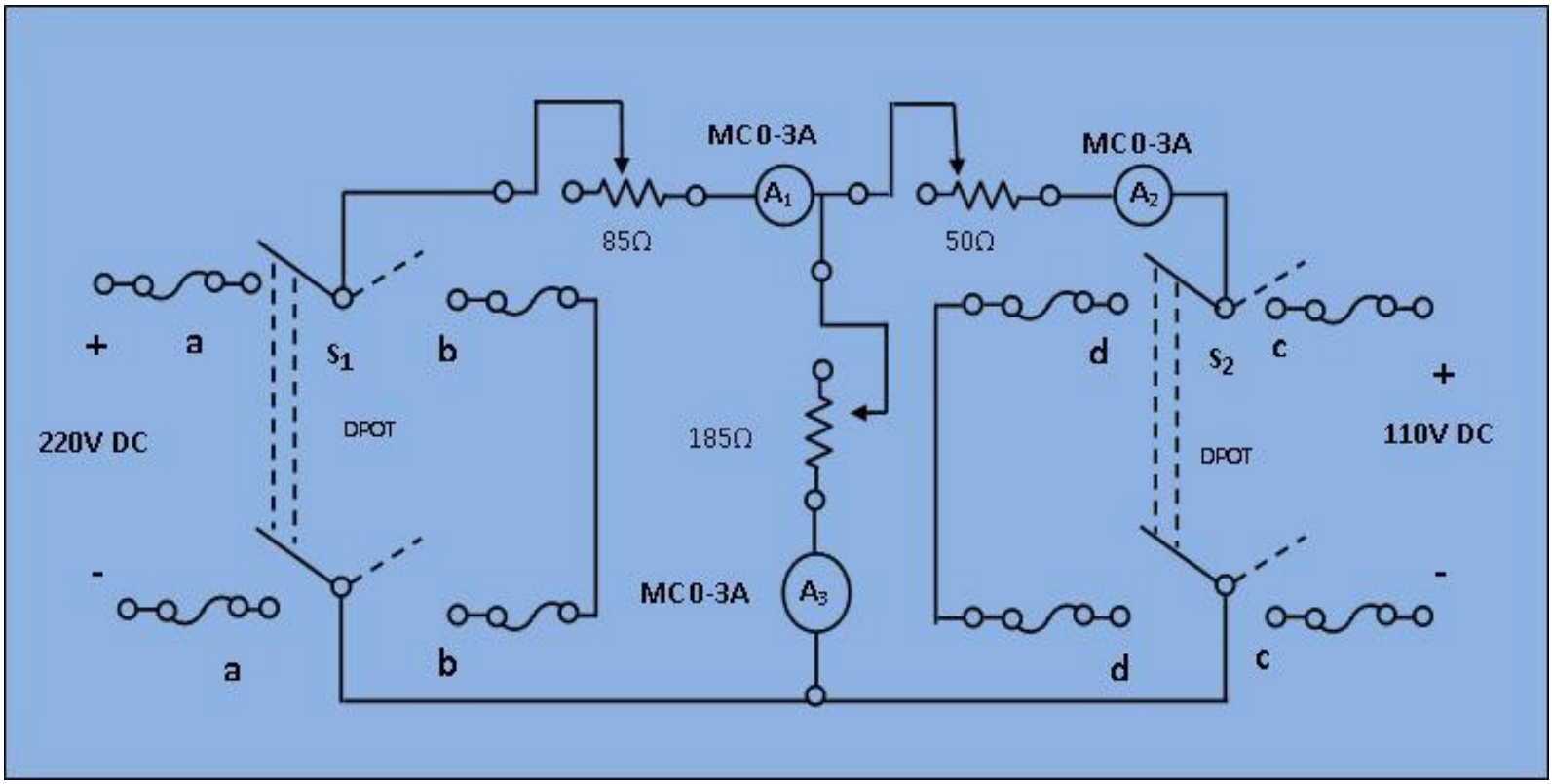
APPLICATION OF TELLEGEN'S THEOREM

The various applications of the **Tellegen's theorem** are as follows:

- It is used in the digital signal processing system for designing filters.
- In the area of the biological and chemical process.
- In topology and structure of reaction network analysis.
- The theorem is used in chemical plants and oil industries to determine the stability of any complex systems.

It is also used in complex operating systems for regulating stability. It is mostly used in the chemical and biological system and for finding the dynamic behaviour of the physical network

PROCEDURE



CIRCUIT DIAGRAM OF EXPERIMENTAL SET-UP FOR VERIFICATION OF
TELLEGEN'S THEOREM

Connect the circuit as shown in the circuit diagram above, keeping the switches open and resistance at their maximum positions.

1. **Case 1:** In presence of both the sources
   Select switch of S_1 to Power and S_2 to Power and switch on the supply to get the ammeter readings. Observe the power supplied in +ve and power dissipated in -ve by the elements and voltage source for this condition.

2. **Case-2:** In presence of V_1 only
   Select switch of S_1 to Power and S_2 to short and switch on the supply. Read the corresponding power values as done in the above case.

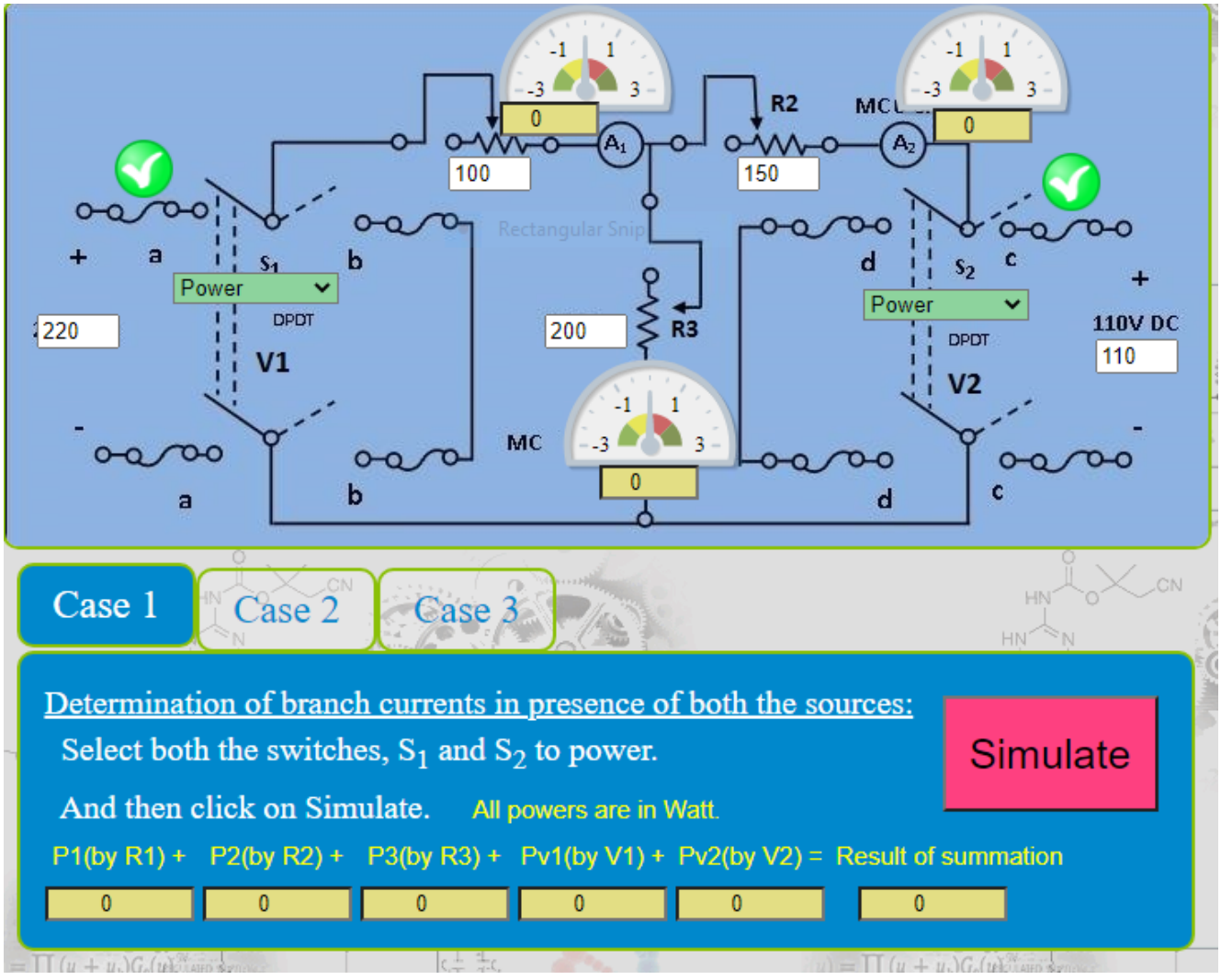
3. **Case-3:** In presence of V_2 only
   Select switch of S_1 to Short and S_2 to switch on the supply. Read the corresponding power values.

Calculate the power consumed or delivered by each element for each case and check if **POWER ABSORBED = POWER DELIVERED.**

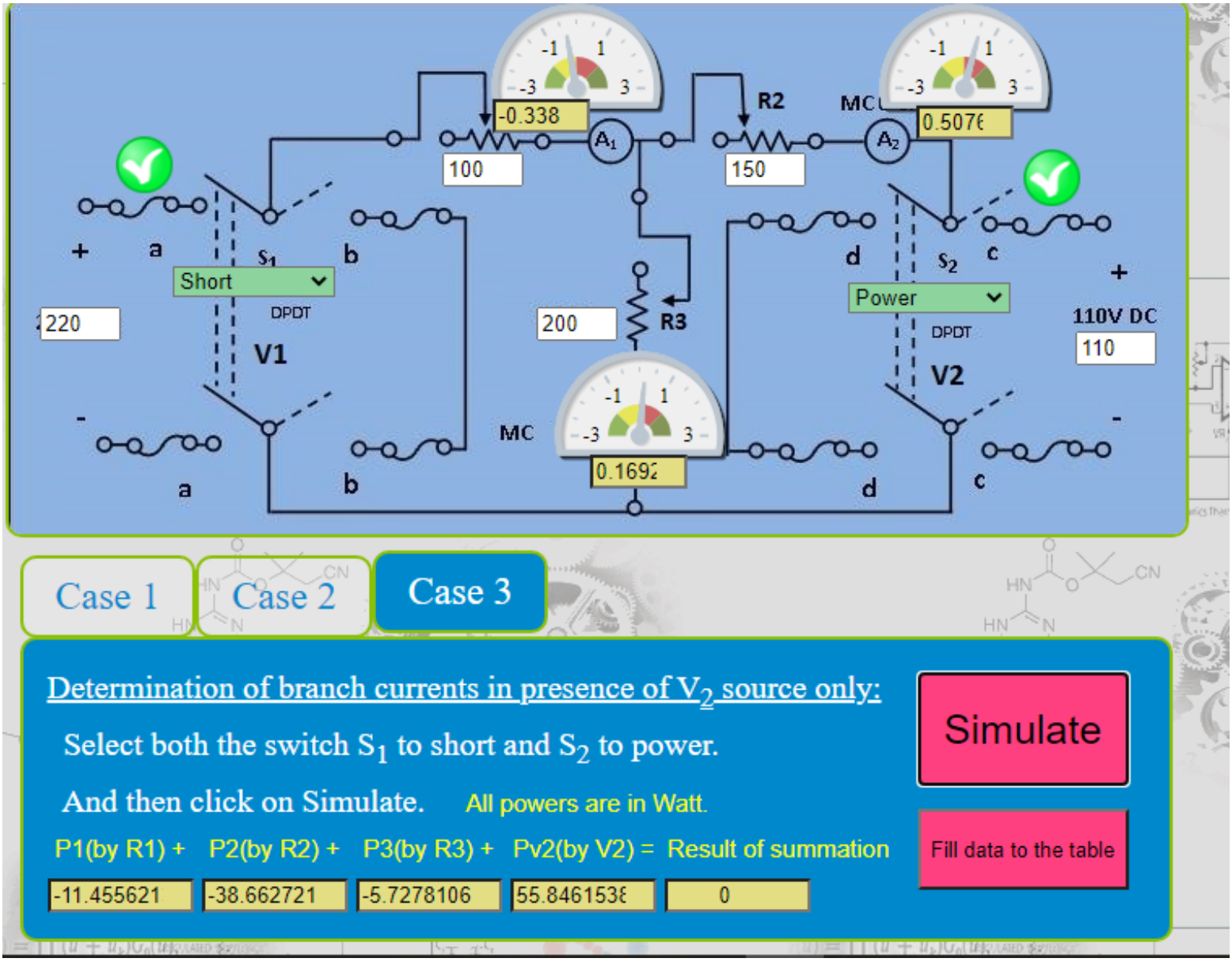
THIS PROVES THE **TELLEGEN'S THEOREM**.

OBSERVATIONS

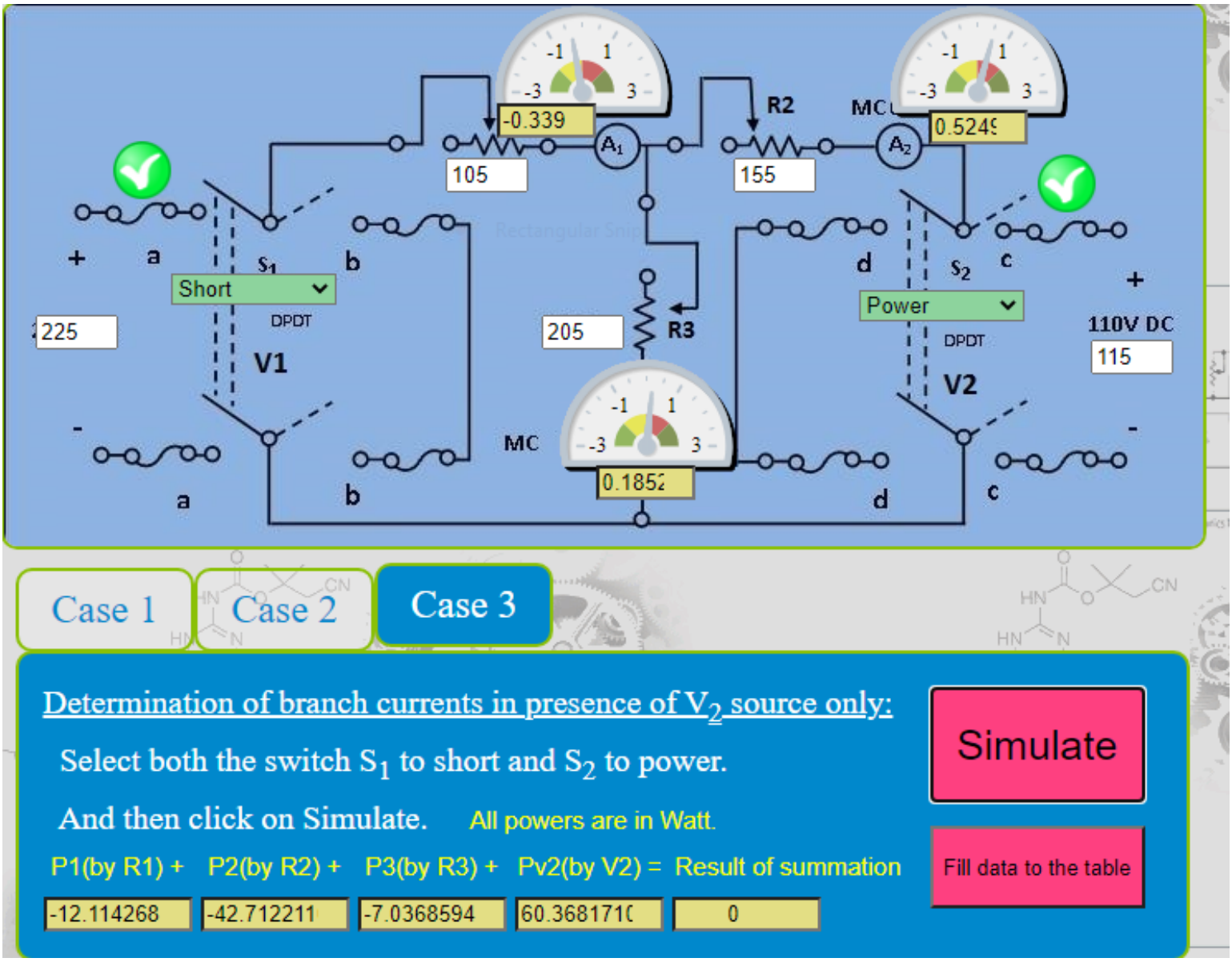
THE READINGS ARE TAKEN FROM THE VLABS



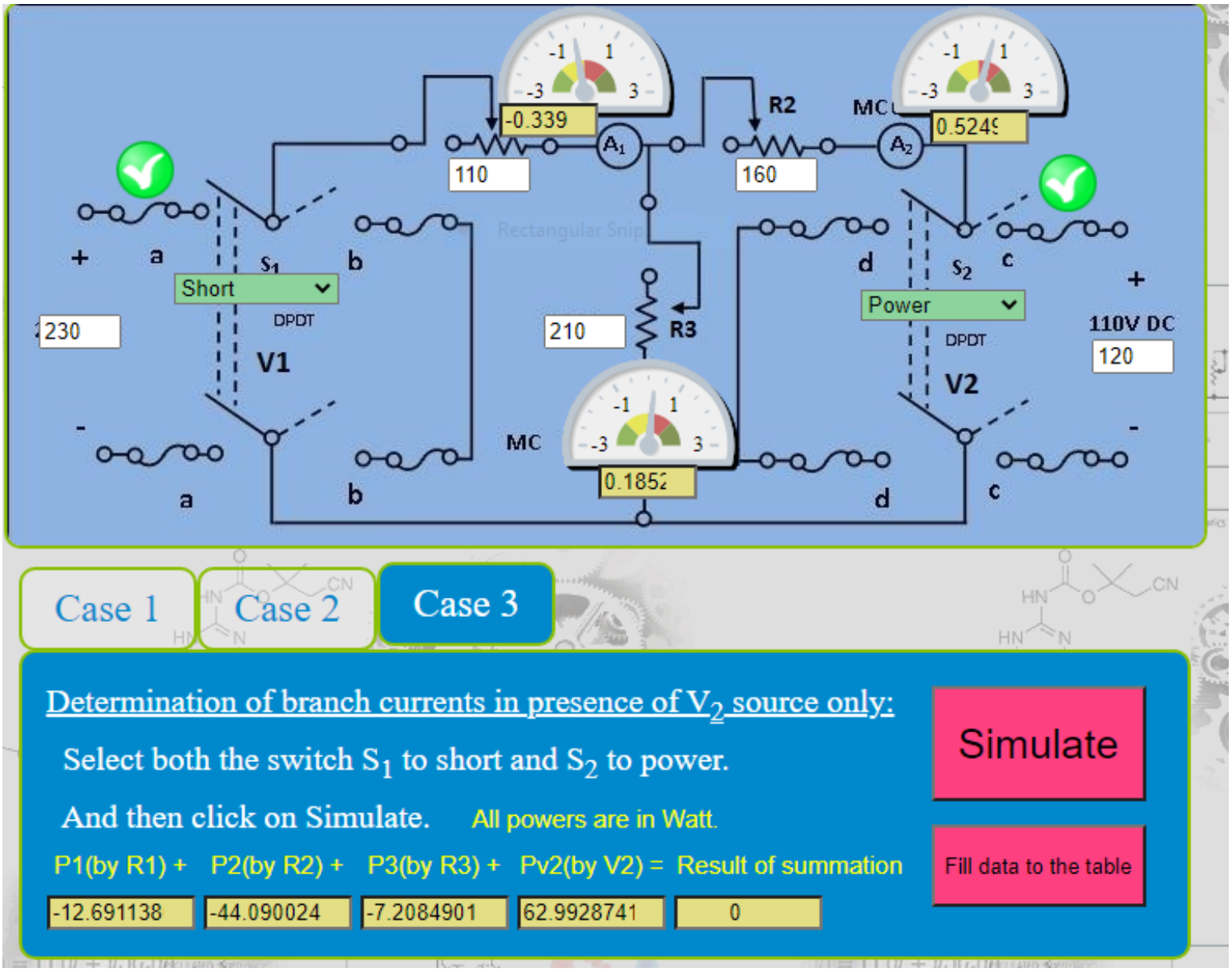
READING 1


-0.338
100
150
0.507
200
0.169
220
110
110V DC
Short
DPDT
V1
Power
DPDT
V2
R2
R3
MC
MC
A1
A2
S1
S2
a
b
c
d
+
-
Case 1
Case 2
Case 3
Determination of branch currents in presence of V2 source only:
Select both the switch S1 to short and S2 to power.
And then click on Simulate.
All powers are in Watt.
Simulate
Fill data to the table
P1(by R1) +
P2(by R2) +
P3(by R3) +
Pv2(by V2) =
Result of summation
-11.455621
-38.662721
-5.7278106
55.846153
0

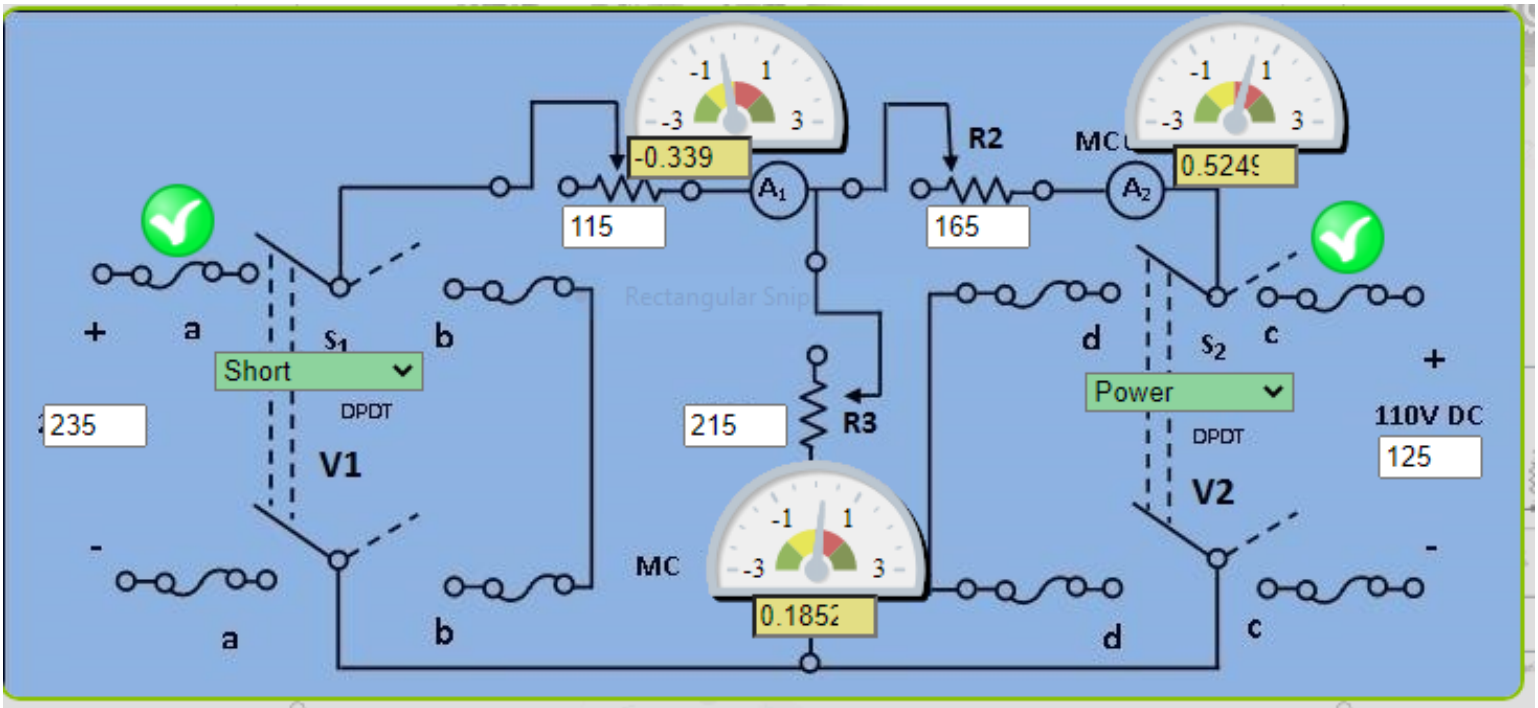
READING 2


-0.339
105
R2
155
0.5249
MC
A1
A2
+
a
S1
Short
DPDT
V1
225
b
205
R3
d
S2
Power
DPDT
V2
c
+
110V DC
115
-
a
b
MC
0.1852
d
c
-
Case 1
Case 2
Case 3
Determination of branch currents in presence of V2 source only:
Select both the switch S1 to short and S2 to power.
And then click on Simulate.
All powers are in Watt.
Simulate
P1(by R1) +
P2(by R2) +
P3(by R3) +
Pv2(by V2) =
Result of summation
Fill data to the table
-12.114268
-42.712211
-7.0368594
60.368171(
0

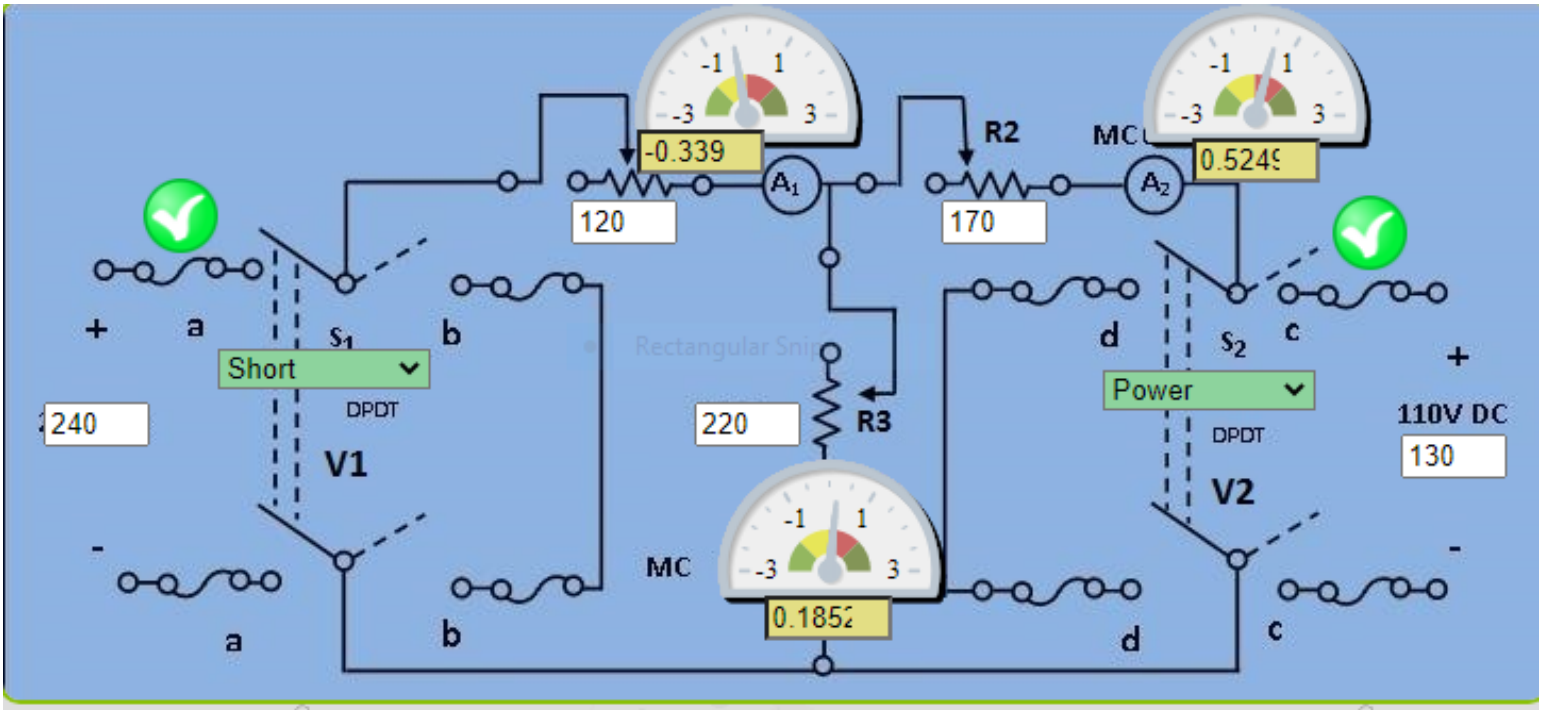
READING 3


-0.339
110
R2
160
0.524
230
Short
DPDT
V1
210
R3
Power
DPDT
V2
110V DC
120
MC
0.185
Case 1
Case 2
Case 3
Determination of branch currents in presence of V_2 source only:
Select both the switch S_1 to short and S_2 to power.
And then click on Simulate.
All powers are in Watt.
Simulate
Fill data to the table
P1(by R1) +
P2(by R2) +
P3(by R3) +
Pv2(by V2) =
Result of summation
-12.691138
-44.090024
-7.2084901
62.9928741
0

READING 4


-0.339
115
R2
165
MC
0.524
235
Short
DPDT
V1
215
R3
Power
DPDT
V2
110V DC
125
MC
0.185
a
b
c
d
Case 1
Case 2
Case 3
Determination of branch currents in presence of V2 source only:
Select both the switch S1 to short and S2 to power.
And then click on Simulate.
All powers are in Watt.
Simulate
Fill data to the table
P1(by R1) +
P2(by R2) +
P3(by R3) +
Pv2(by V2) =
Result of summation
-13.268007
-45.467837
-7.3801208
65.6175771
0

READING 5



Case 1 | Case 2 | Case 3

Determination of branch currents in presence of V_2 source only:

Select both the switch S_1 to short and S_2 to power.

And then click on Simulate. All powers are in Watt.

Simulate

Fill data to the table

P1(by R1) +	P2(by R2) +	P3(by R3) +	Pv2(by V2) =	Result of summation
-13.844877	-46.845650	-7.5517515	68.2422802	0

OBSERVATION TABLE

Observation Table:

Sl no.	In presence of both V_1 and V_2 All values are in Watt					In presence of V_1 only All values are in Watt				In presence of V_2 only All values are in Watt			
	P_1(by R_1)	P_2(by R_2)	P_3(by R_3)	Pv_1(by V_1)	Pv_2(by V_2)	P_1(by R_1)	P_2(by R_2)	P_3(by R_3)	Pv_1(by V_1)	P_1(by R_1)	P_2(by R_2)	P_3(by R_3)	Pv_2(by V_2)
1	-71.5	-4.29	-91.6	186.1	-18.6	-140.	-68.7	-51.5	260.6	-11.4	-38.6	-5.72	55.84
2	-71.5	-3.51	-93.3	185.7	-17.3	-142.	-68.1	-51.5	261.9	-12.0	-40.6	-6.17	58.92
3	-71.4	-2.84	-95.1	185.4	-15.9	-144.	-67.6	-51.5	263.4	-12.6	-42.7	-6.62	62.01
4	-71.4	-2.26	-96.8	185.2	-14.6	-146.	-67.1	-51.5	265.0	-13.2	-44.7	-7.08	65.12
5	-71.5	-1.77	-98.7	185.2	-13.2	-148.	-66.8	-51.6	266.7	-13.8	-46.8	-7.55	68.24

RESULT/CONCLUSION :-

THE ABOVE READINGS OF THE **OBSERVATION TABLE** AS THE SUMMATON OF ALL **POWER** VALUES EQUALS TO **ZERO** WHICH VERIFIES THE

TELLENGEN'S THEOREM

HENCE , TELLENGEN THEOREM HAS BEEN VERIFIED