TOLENTINO ROMERO GERARDO

Análisis y Diseño de Algoritmos

Andres Garcia Floriano

Practica 7

Mi solución propuesta para la solución del problema es:

```python
arr = [2,2,2,2,5,5,5,8]

k = 3
threshold = 4
subArrays = list()
n = len(arr)

for i in range(n-k+1):
    count = 0
    avg = 0
    for j in range (k):
        count += arr[i+j]
        if j==k-1:
            avg = count/k
            if avg >= threshold:
                subArrays.append(arr[i:i+k:])

numSubArrays = len(subArrays)
print(f"Para {arr} el numero de sub-arrays de longitud {k} y que promedien {threshold} es: {numSubArrays} y son los siguientes: {subArrays}")
```

La salida para [11,13,17,23,29,31,7,5,2,3]

Es la siguiente:

```
Para [11, 13, 17, 23, 29, 31, 7, 5, 2, 3] el numero de sub-arrays de longitud 3 y que promedien 5 es: 6 y son lo
s siguientes: [[11, 13, 17], [13, 17, 23], [17, 23, 29], [23, 29, 31], [29, 31, 7], [31, 7, 5]]
```

La salida para [2,2,2,2,5,5,5,8]

Es la siguiente:

```
Para [2, 2, 2, 2, 5, 5, 5, 8] el numero de sub-arrays de longitud 3 y que promedien 4 es: 3 y son los siguientes
: [[2, 5, 5], [5, 5, 5], [5, 5, 8]]
```

El algoritmo funciona correctamente haciendo las sumas de tres números consecutivos y calculando el promedio de esos, así mismo está diseñado para funcionar con cualquier valor para k y para threshold

INSTITUTO POLITÉCNICO NACIONAL
ESCUELA SUPERIOR DE CÓMPUTO
LABORATORIO DE CIRCUITOS ELÉCTRICOS

PRÁCTICA No. 8:

"TEOREMA DE SUPERPOSICIÓN"

UNIDAD DE APRENDIZAJE: *CIRCUITOS ELÉCTRICOS*

GRUPO: 3CV2

EQUIPO: 6

INTEGRANTES:

Tolentino Romero Gerardo

PROFESOR:

FECHA DE REALIZACIÓN: 11-11-2024

FECHA DE ENTREGA: 18-11-2024

COMENTARIOS:

INTRODUCTION

The superposition theorem is a fundamental principle in electrical circuit analysis, particularly in linear systems. It provides a systematic method to analyze circuits with multiple independent sources (voltage or current) by considering the contribution of each source individually. This simplifies complex circuits and makes solving them more intuitive. Some concepts to take into account are

Linear Systems:

The superposition theorem applies exclusively to linear systems, where the relationship between voltage and current is linear (i.e., follows Ohm's Law). Examples include resistors and ideal voltage/current sources. Non-linear components, such as diodes or transistors, do not satisfy this condition.

Independent Sources:

Independent sources are those whose values are not influenced by other elements in the circuit. These include constant voltage sources (e.g., batteries) and current sources.

Contribution Analysis:

In the superposition process, each independent source is considered one at a time, while all other sources are temporarily replaced:

- Voltage sources are replaced by short circuits (zero voltage).
- Current sources are replaced by open circuits (zero current).

  This allows us to calculate the effect of a single source on the circuit.

Linear Superposition:

Once the individual contributions from all sources are calculated, the total response (voltage or current at a specific point) is found by summing these contributions.

The superposition theorem simplifies the analysis of electrical circuits by allowing us to consider one independent source at a time while temporarily replacing other sources.

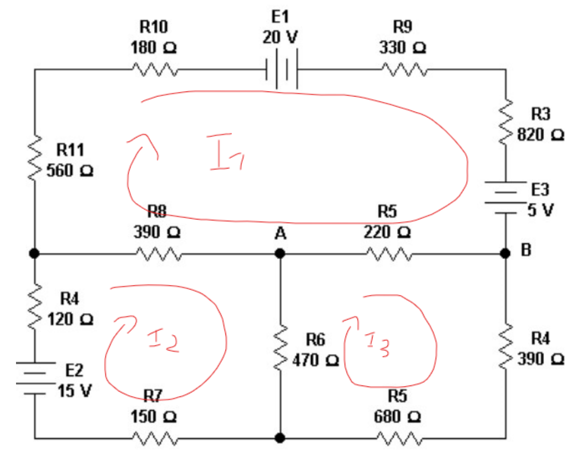
To apply this correctly, it is crucial to systematically replace voltage sources with short circuits (zero voltage) and current sources with open circuits (zero current). Although the theorem is a powerful tool, special attention must be given when dealing with active components, such as dependent sources, as these require a more nuanced approach.

Overall, the superposition theorem is widely applied in the analysis of electrical networks, circuit design, and troubleshooting, making it an essential concept in electrical engineering.

By breaking down complex problems into manageable parts, the superposition theorem offers an elegant solution for analyzing multi-source circuits. Understanding the linearity principle and the role of independent sources is key to effectively applying this theorem.

PRACTICE DEVELOPMENT

First circuit



$\mathbf{I_1}: -20\text{v} + \text{V}_{\text{R9}} + \text{V}_{\text{R3}} + 5\text{v} + \text{V}_{\text{R5}} + \text{V}_{\text{R8}} + \text{V}_{\text{R11}} + \text{V}_{\text{R10}} = 0$

$$330I_1 + 820I_1 + (I_1 - I_3)220 + (I_1 - I_2)390 + 560I_1 + 180I_1 = 15$$

$$2500I_1 - 390I_2 - 220I_3 = 15$$

$\boldsymbol{I_2}: -15v + V_{R4} + V_{R8} + V_{R6} + V_{R7} = 0$

$$120I_2 + (I_2 - I_1)390 + (I_2 - I_3)470 + 150I_2 = 15$$

$$-390I_1 + 1130I_2 - 470I_3 = 15$$

$\boldsymbol{I_3}: V_{R6} + V_{R5} + V_{R5} + V_{R4}$=0

$$(I_3 - I_1)220 + 390I_3 + 680I_3 + (I_3 - I_2)470 = 0$$

$$-220I_1 - 470I_2 + 1760I_3 = 0$$

$$|s| = \left|\begin{pmatrix} 2500 & -390 & -220 \\ -390 & 1130 & -470 \\ -220 & -470 & 1760 \end{pmatrix}\right| = 4016710000$$

$$|I_1| = \left|\begin{pmatrix} 15 & -390 & -220 \\ 15 & 1130 & -470 \\ -0 & -470 & 1760 \end{pmatrix}\right|$$=38365500

$$|I_2| = \left|\begin{pmatrix} 2500 & 15 & -220 \\ -390 & 15 & -470 \\ -220 & 0 & 1760 \end{pmatrix}\right| = 77121000$$

$$|I_3| = \left|\begin{pmatrix} 2500 & -390 & 15 \\ -390 & 1130 & 15 \\ -220 & -470 & 0 \end{pmatrix}\right|$$=25390500

$$I_1 = \frac{|I_1|}{|s|} = \frac{38365500}{4016710000} = 0.009551473719 = 9.55mA$$

$$I_2 = \frac{|I_2|}{|s|} = \frac{77121000}{4016710000} = 0.01920004183 = 19.20mA$$

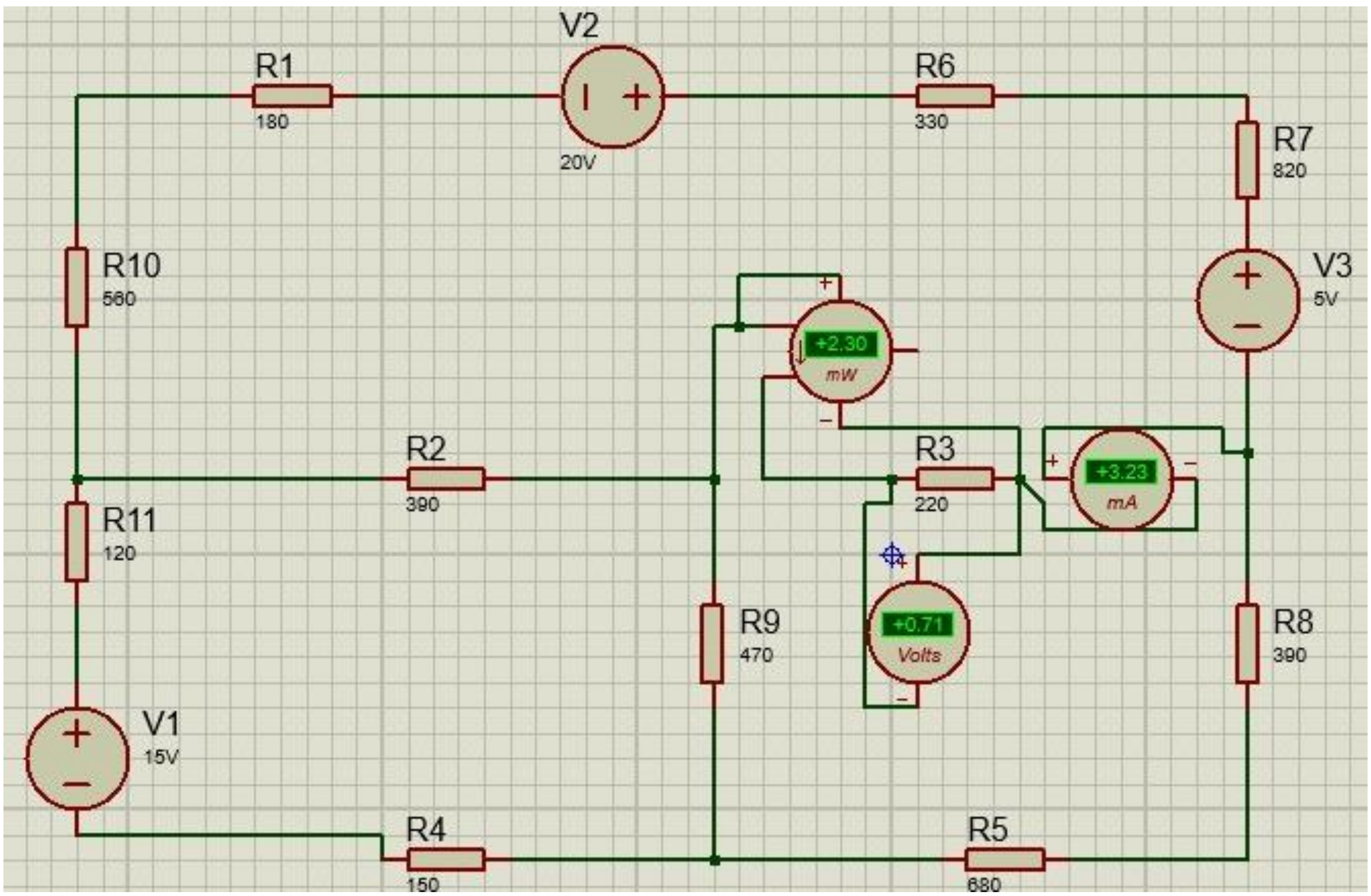
$$I_3 = \frac{|I_3|}{|s|} = \frac{25390500}{4016710000} = 0.006321218111 = 6.32mA$$

$$I_{AB} = I_1 - I_3 = 9.55mA - 6.32mA = 3.23mA$$

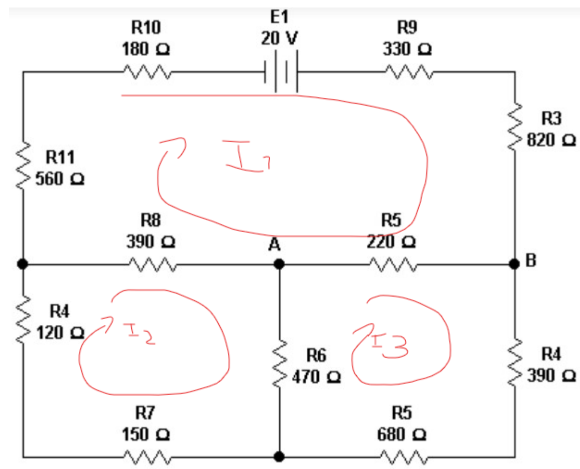
$$V_{AB} = I_{AB} * R_{220} = 3.23mA * 220\Omega = 0.710\ V$$

$$P_{AB} = V_{AB} * I_{AB} = 3.23mA * 0.710V = 2.29mW$$

Measurements	Theoretical value	Measured value
I_{AB}	$3.23mA$	$2.98mA$
V_{AB}	$0.710\ V$	$0.702\ V$
P_{AB}	$2.29mW$	$2.09mw$



Second circuit



$\mathbf{I_1}: -20\mathrm{v} + \mathrm{V_{R9}} + \mathrm{V_{R3}} + \mathrm{V_{R5}} + \mathrm{V_{R8}} + \mathrm{V_{R11}} + \mathrm{V_{R10}} = 0$

$$330I_1 + 820I_1 + (I_1 - I_3)220 + (I_1 - I_2)390 + 560I_1 + 180I_1 = 20$$

$$2500I_1 - 390I_2 - 220I_3 = 15$$

$\boldsymbol{I_2}: V_{R4} + V_{R8} + V_{R6} + V_{R7} = 0$

$$120I_2 + (I_2 - I_1)390 + (I_2 - I_3)470 + 150I_2 = 0$$

$$-390I_1 + 1130I_2 - 470I_3 = 0$$

$\boldsymbol{I_3}: V_{R6} + V_{R5} + V_{R5} + V_{R4}$=0

$$(I_3 - I_1)220 + 390I_3 + 680I_3 + (I_3 - I_2)470 = 0$$

$$-220I_1 - 470I_2 + 1760I_3 = 0$$

$$|s| = \left|\begin{pmatrix} 2500 & -390 & -220 \\ -390 & 1130 & -470 \\ -220 & -470 & 1760 \end{pmatrix}\right| = 4016710000 \qquad |I'_1| = \left|\begin{pmatrix} 20 & -390 & -220 \\ 0 & 1130 & -470 \\ 0 & -470 & 1760 \end{pmatrix}\right| = 35358000$$

$$|I'_2| = \left|\begin{pmatrix} 2500 & 20 & -220 \\ -390 & 0 & -470 \\ -220 & 0 & 1760 \end{pmatrix}\right| = 15796000 \qquad |I'_3| = \left|\begin{pmatrix} 2500 & -390 & 20 \\ -390 & 1130 & 0 \\ -220 & -470 & 0 \end{pmatrix}\right| = 8638000$$

$$I'_1 = \frac{|I'_1|}{|s|} = \frac{35358000}{4016710000} = 0.00880272661 = 8.80mA$$

$$I'_2 = \frac{|I'_2|}{|s|} = \frac{15796000}{4016710000} = 0.003932571682 = 3.93mA$$

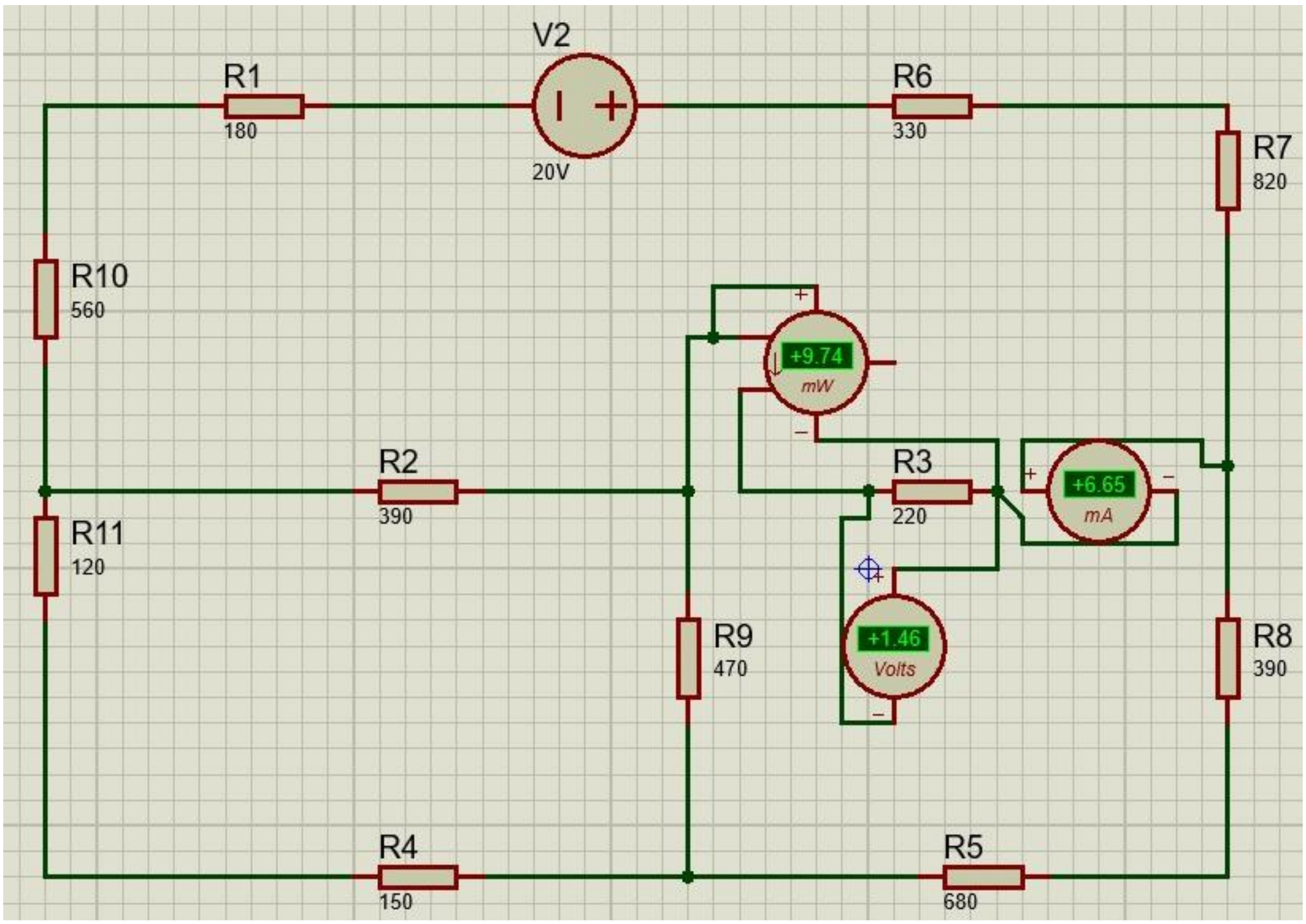
$$I'_3 = \frac{|I'_3|}{|s|} = \frac{8638000}{4016710000} = 0.002150516218 = 2.15mA$$

$$I'_{AB} = I'_1 - I'_3 = 8.80mA - 2.15mA = 6.65mA$$

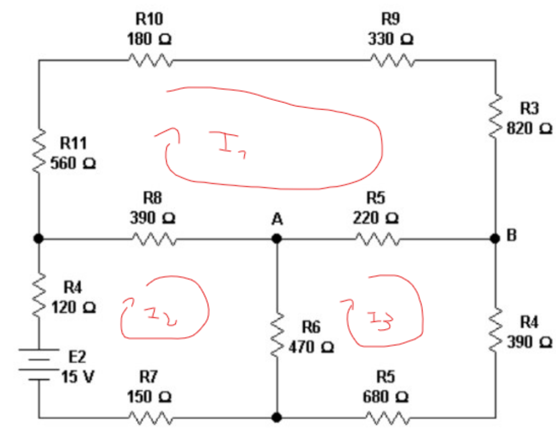
$$V'_{AB} = I_{AB} * R_{220} = 6.65mA * 220\Omega = 1.46\ V$$

$$P'_{AB} = V_{AB} * I_{AB} = 6.65mA * 1.463\ V = 9.72mW$$

Measurements	Theoretical value	Measured value
I'_{AB}	$6.65mA$	$6.75mA$
V'_{AB}	$1.46\,V$	$1.46\,V$
P'_{AB}	$9.72mW$	$9.85mw$



Third circuit



$\mathbf{I_1}$: $V_{R9} + V_{R3} + V_{R5} + V_{R8} + V_{R11} + V_{R10} = 0$

$$330I_1 + 820I_1 + (I_1 - I_3)220 + (I_1 - I_2)390 + 560I_1 + 180I_1 = 0$$

$$2500I_1 - 390I_2 - 220I_3 = 0$$

$\boldsymbol{I_2}$: $-15V + V_{R4} + V_{R8} + V_{R6} + V_{R7} = 0$

$$120I_2 + (I_2 - I_1)390 + (I_2 - I_3)470 + 150I_2 = 15$$

$$-390I_1 + 1130I_2 - 470I_3 = 15$$

$\boldsymbol{I_3}$: $V_{R6} + V_{R5} + V_{R5} + V_{R4}$=0

$$(I_3 - I_1)220 + 390I_3 + 680I_3 + (I_3 - I_2)470 = 0$$

$$-220I_1 - 470I_2 + 1760I_3 = 0$$

$$|s| = \left|\begin{pmatrix} 2500 & -390 & -220 \\ -390 & 1130 & -470 \\ -220 & -470 & 1760 \end{pmatrix}\right| = 4016710000 \qquad |I''_1| = \left|\begin{pmatrix} 0 & -390 & -220 \\ 15 & 1130 & -470 \\ 0 & -470 & 1760 \end{pmatrix}\right| = 11847000$$

$$|I''_2| = \left|\begin{pmatrix} 2500 & 0 & -220 \\ -390 & 15 & -470 \\ -220 & 0 & 1760 \end{pmatrix}\right| = 65274000 \qquad |I''_3| = \left|\begin{pmatrix} 2500 & -390 & 0 \\ -390 & 1130 & 15 \\ -220 & -470 & 0 \end{pmatrix}\right| = 18912000$$

$$I''_1 = \frac{|I''_1|}{|s|} = \frac{11847000}{4016710000} = 0.002949428761 = 2.94mA$$

$$I''_2 = \frac{|I''_2|}{|s|} = \frac{65274000}{4016710000} = 0.01625061306 = 16.25mA$$

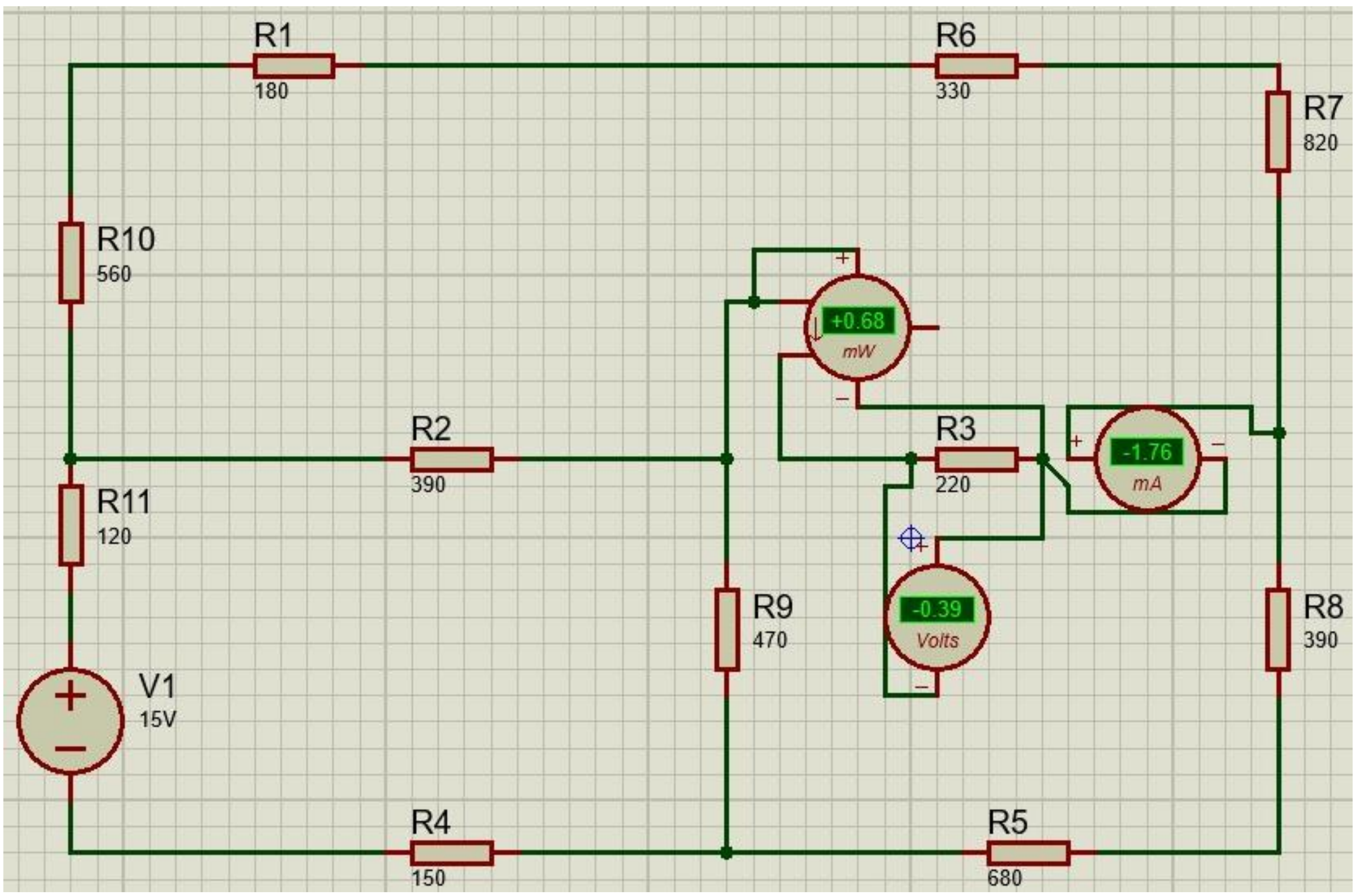
$$I''_3 = \frac{|I''_3|}{|s|} = \frac{18912000}{4016710000} = 0.004708330947 = 4.70mA$$

$$I''_{AB} = I''_1 - I'_3 = 2.94mA - 4.70mA = -1.76mA$$

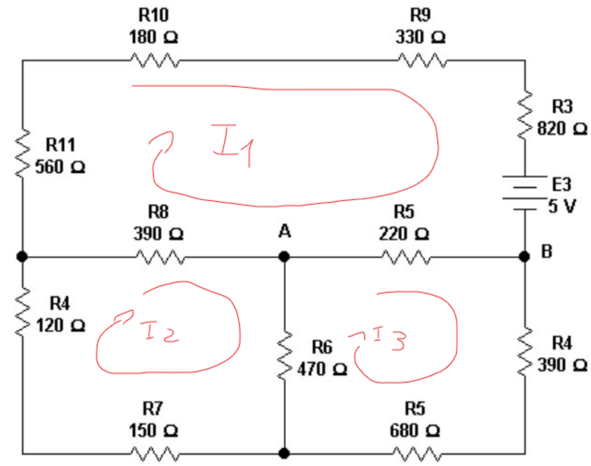
$$V''_{AB} = I_{AB} * R_{220} = -1.76mA * 220\Omega = -0.3872V$$

$$P''_{AB} = V_{AB} * I_{AB} = -1.76mA * -0.3872V = -0.681mW$$

Measurements	**Theoretical value**	**Measured value**
I''_{AB}	$-1.76mA$	$-1.66mA$
V''_{AB}	$-0.3872\,V$	$-0.393\,V$
P''_{AB}	$-0.681mW$	$0.652mw$



Third circuit



$$\mathbf{I_1}: 5\mathrm{V}_{\mathrm{R9}} + \mathrm{V}_{\mathrm{R3}} + \mathrm{V}_{\mathrm{R5}} + \mathrm{V}_{\mathrm{R8}} + \mathrm{V}_{\mathrm{R11}} + \mathrm{V}_{\mathrm{R10}} = 0$$

$$330I_1 + 820I_1 + (I_1 - I_3)220 + (I_1 - I_2)390 + 560I_1 + 180I_1 = -5$$

$$2500I_1 - 390I_2 - 220I_3 = -5$$

$$\boldsymbol{I_2}: V_{R4} + V_{R8} + V_{R6} + V_{R7} = 0$$

$$120I_2 + (I_2 - I_1)390 + (I_2 - I_3)470 + 150I_2 = 0$$

$$-390I_1 + 1130I_2 - 470I_3 = 0$$

$$\boldsymbol{I_3}: V_{R6} + V_{R5} + V_{R5} + V_{R4}=0$$

$$(I_3 - I_1)220 + 390I_3 + 680I_3 + (I_3 - I_2)470 = 0$$

$$-220I_1 - 470I_2 + 1760I_3 = 0$$

$$|s| = \left|\begin{pmatrix} 2500 & -390 & -220 \\ -390 & 1130 & -470 \\ -220 & -470 & 1760 \end{pmatrix}\right| = 4016710000 \qquad |I'''_1| = \left|\begin{pmatrix} -5 & -390 & -220 \\ 0 & 1130 & -470 \\ 0 & -470 & 1760 \end{pmatrix}\right| = -8839500$$

$$|I''_2| = \left|\begin{pmatrix} 2500 & -5 & -220 \\ -390 & 0 & -470 \\ -220 & 0 & 1760 \end{pmatrix}\right| = -3969000 \qquad |I'''_3| = \left|\begin{pmatrix} 2500 & -390 & -5 \\ -390 & 1130 & 0 \\ -220 & -470 & 0 \end{pmatrix}\right| = -2159500$$

$$I'''_1 = \frac{|I''_1|}{|s|} = \frac{-8839500}{4016710000} = -0.002200681652 = -2.20mA$$

$$I'''_2 = \frac{|I''_2|}{|s|} = \frac{-3969000}{4016710000} = -0.00098812212 = -0.988mA$$

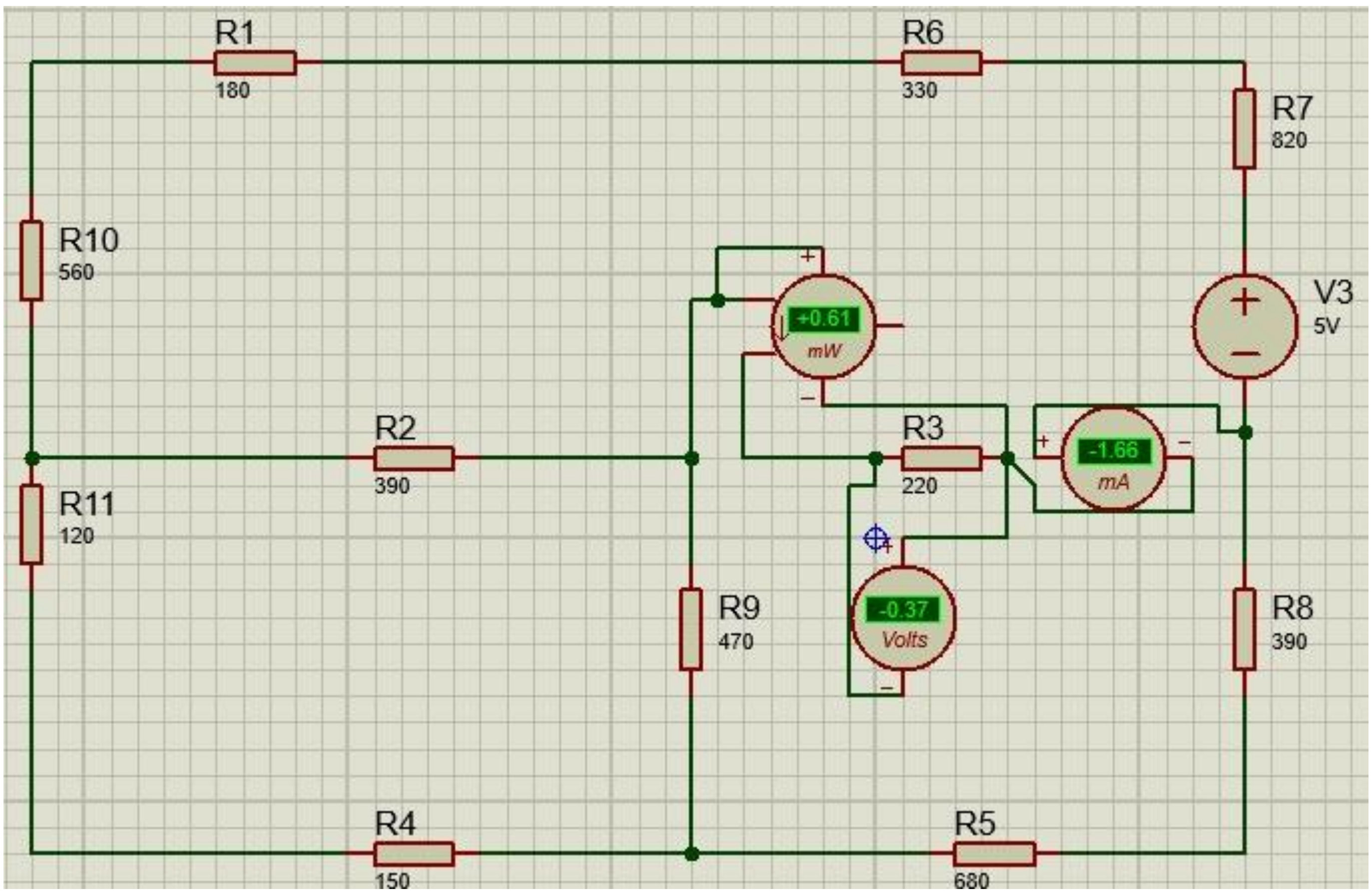
$$I'''_3 = \frac{|I''_3|}{|s|} = \frac{-2159500}{4016710000} = -0.000537629055 = -0.537mA$$

$$I'''_{AB} = I''_1 - I'_3 = -2.20mA - (-0.537mA) = -2.20mA + 0.537mA = -1.66mA$$

$$V'''_{AB} = I_{AB} * R_{220} = -1.66mA * 220\Omega = -0.3652V$$

$$P'''_{AB} = V_{AB} * I_{AB} = -1.66mA * -0.3652V = -0.606mW$$

Measurements	Theoretical value	Measured value
I'''_{AB}	$-1.66mA$	$-1.65mA$
V'''_{AB}	$-0.3652\,V$	$-0.365\,V$
P'''_{AB}	$-0.0606mW$	$-0.0606mw$



Measurements	**Theoretical value**	**Measured value**	**Simulated value**
$I_{AB} = I'_{AB+}I''_{AB} + I'''_{AB}$	$3.23mA$	$3.44mA$	$3.23mA$
$V_{AB} = V'_{AB} + V''_{AB} + V'''_{AB}$	$0.7076\,V$	$0.702V$	$0.7v$
$P_{AB} = P'_{AB} + P''_{AB} + P'''_{AB}$	$8.97mW$	$9.13mw$	$8.45mW$

Questionnaire

1. **What does the Superposition Theorem state?**
   The superposition theorem states that in a linear electrical circuit with multiple independent sources, the total response (voltage or current) at any point in the circuit is equal to the sum of the responses caused by each independent source acting alone. When analyzing one source, all other independent sources are replaced by their equivalent inactive states (voltage sources are short-circuited, and current sources are open-circuited).
2. **Why does the PR5 obtained in point VI not match the one obtained in point II of the development?**
   The discrepancy occurs because the superposition theorem analyzes voltage and current contributions individually for each source but does not apply directly to power calculations. Power is a non-linear quantity (proportional to the square of current or voltage), so the sum of individual power contributions does not equal the total power in the circuit.
3. **What is the usefulness of the Superposition Theorem in circuit theory?**
   The superposition theorem is highly useful in simplifying the analysis of circuits with multiple independent sources. It breaks complex problems into simpler parts by allowing the study of one source at a time. This makes it easier to calculate voltages and currents in linear circuits and provides a systematic approach to understanding the contributions of each source in the overall circuit behavior.

Conclusión

In conclusion, the superposition theorem demonstrates that the algebraic sum of the current and voltage values between two points, A and B, obtained by considering each independent source individually while deactivating the others, converges to the values in the original circuit with all sources active. This confirms the validity of the theorem for linear circuit analysis. However, it is important to note that power calculations exhibit a discrepancy because power is a nonlinear quantity. The total power in the circuit cannot be determined by simply summing the contributions from each individual source, highlighting a limitation of the theorem in analyzing energy-related parameters.

References

Carnegie Mellon University. (s.f.). Superposition of Power. Recuperado de https://users.ece.cmu.edu