

Paper 1, TDC Part-1
Chapter– 4, Circuit Theorems
Lecture – 1 Superposition Theorem

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Circuit Theorem – Superposition Theorem

- In previous chapter general methods of network analysis taught. In complex network, general methods are laborious and time-consuming.
- There are some theorems that reduce the task and time of network analysis, these theorem are called Network theorem.
- The other features of the theorems are:
 - Applicable to fairly wide class of networks.

Circuit Theorem – Superposition Theorem

- Conclusion are simple.
- Provide good insight into the problems.

These Network Theorems are:-

- Superposition Theorem
- Thevenin's Theorem
- Norton's Theorem
- Maximum Power Transfer
- Reciprocity Theorem
- Star-Delta Transformation

Circuit Theorem – Superposition Theorem

a. Superposition Theorem :-

The theorem states that in a linear network that contains two or more independent active sources, can be analyzed to obtain the various voltages and branch currents by allowing the sources to act one at a time, then adding the responses due to each independent sources.

This principle applies due to the linear relationship between voltage and current.

Circuit Theorem – Superposition Theorem

Steps for applying superposition theorem in circuit.

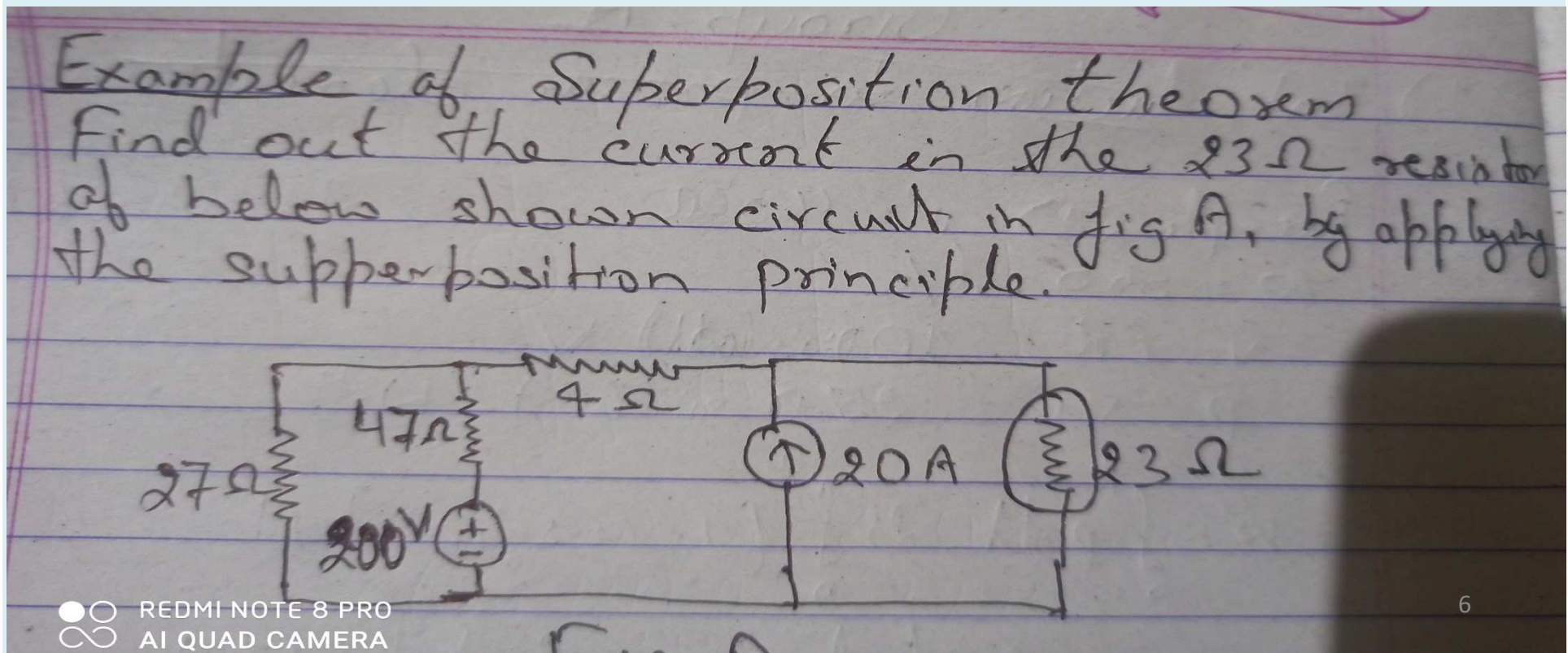
- 1) Take any one (either voltage or current) source.
- 2) Short circuited the other voltage source in the circuit
- 3) Open circuit the other current source in the circuit.
- 4) Now find out the voltage/ current in the required circuit element.
- 5) Now consider the other source and repeat the steps from 2 to 4.

Circuit Theorem – Superposition Theorem

6) Steps 2 and 3 will be also valid for the sources considered previously.

7) Repeat steps 5 and 6 for all the sources.

Example:-



Circuit Theorem – Superposition Theorem

Solⁿ. We have to find out total current in 23Ω resistor which has been encircled in fig A.

In this circuit there are two sources, one is voltage source of $200V$ and other is current source of $20A$.

When we apply ~~super~~ superposition theorem in above ckt we can take any ^{one} of the source 1st. Here let us take current source and then draw the ckt again as below.

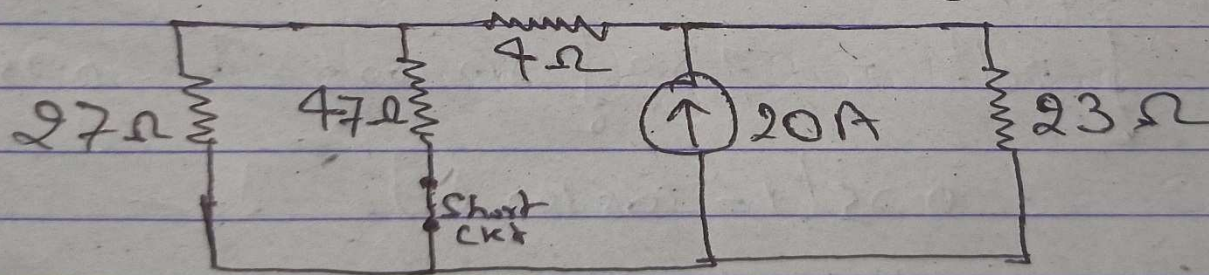


fig A(1)

consider current source first, so voltage

Circuit Theorem – Superposition Theorem

source has been short circuited as mentioned in step 2.

When we short circuited the voltage source then resistance $27\ \Omega$ and $47\ \Omega$ are in $||$ rd.
So,

$$R_{||} = \frac{27 \times 47\ \Omega}{(27 + 47)}$$

Now this $||$ rd resistance is in series with $4\ \Omega$ resistance as shown below.

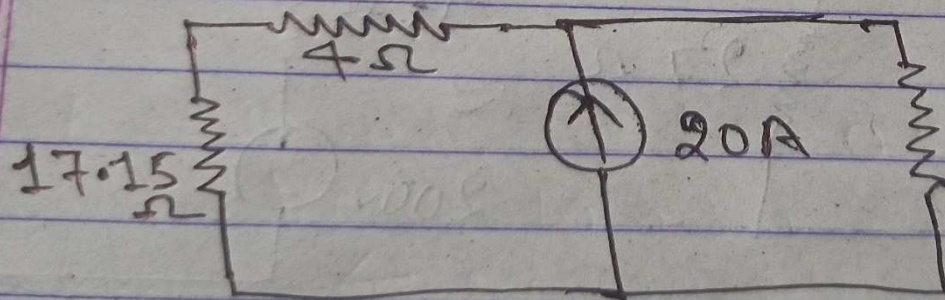


Fig A(2)

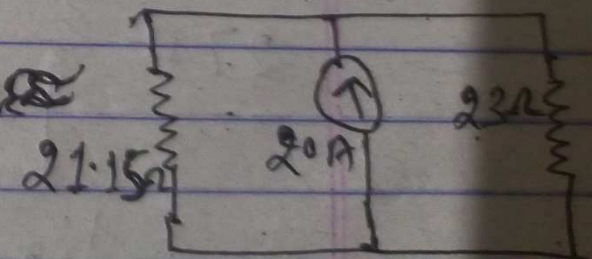


Fig A(3)

Circuit Theorem – Superposition Theorem

$$R_{\text{series}} = (4 \Omega + 17.15 \Omega) = 21.15 \Omega$$

Now the ~~the~~ current source is of 20 A so it will deliver 20 A current which will be divide among 23Ω & 21.15Ω resistors.

So current in 23Ω resistor due to 20 A source

is

$$I'_{23\Omega} = 20 \times \frac{21.15}{(21.15 + 23)} = 9.58 \text{ A}$$

└ (i)

Now considering the voltage source 200 V and find the current in 23Ω resistor due to 200 V

This time open circuit the current source as shown in fig A(4)

Circuit Theorem – Superposition Theorem

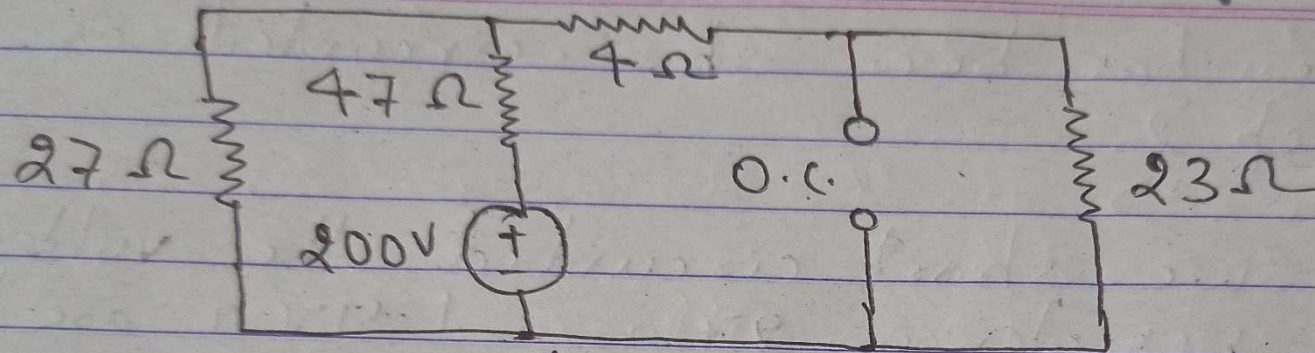


Fig A(4)

Now, $23\ \Omega$ resistance & $4\ \Omega$ are in series so,
 $R_{series} = (23 + 4)\ \Omega = 27\ \Omega$

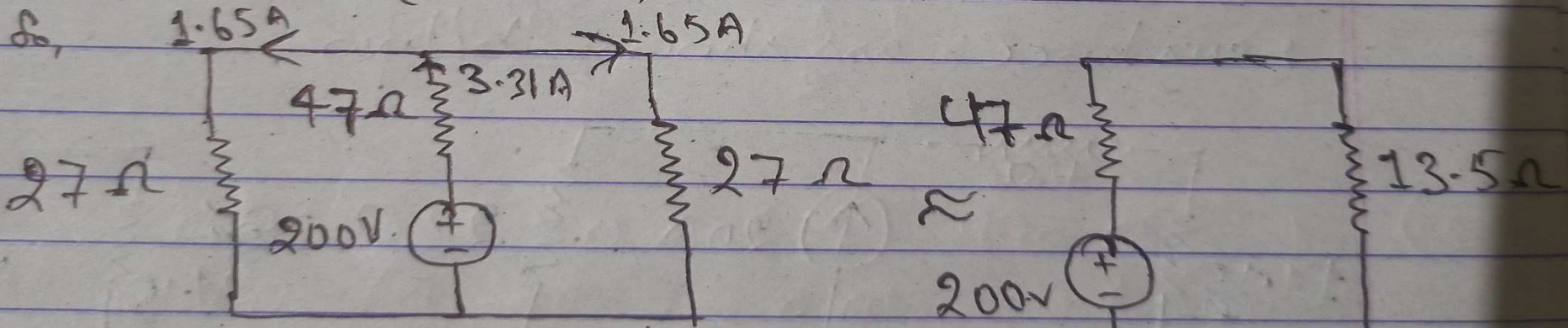


Fig A(5)

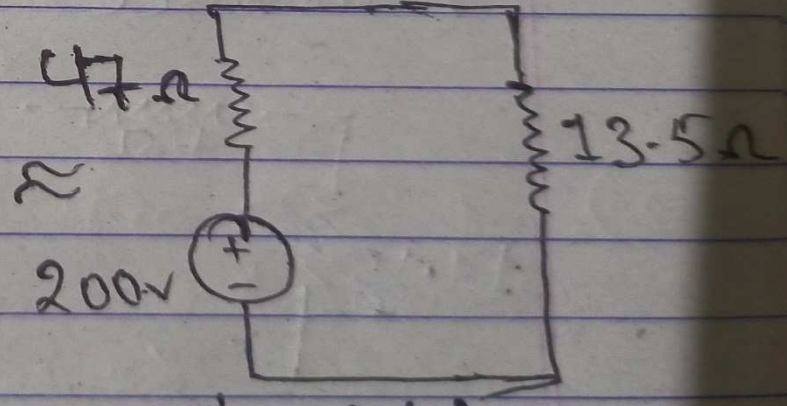
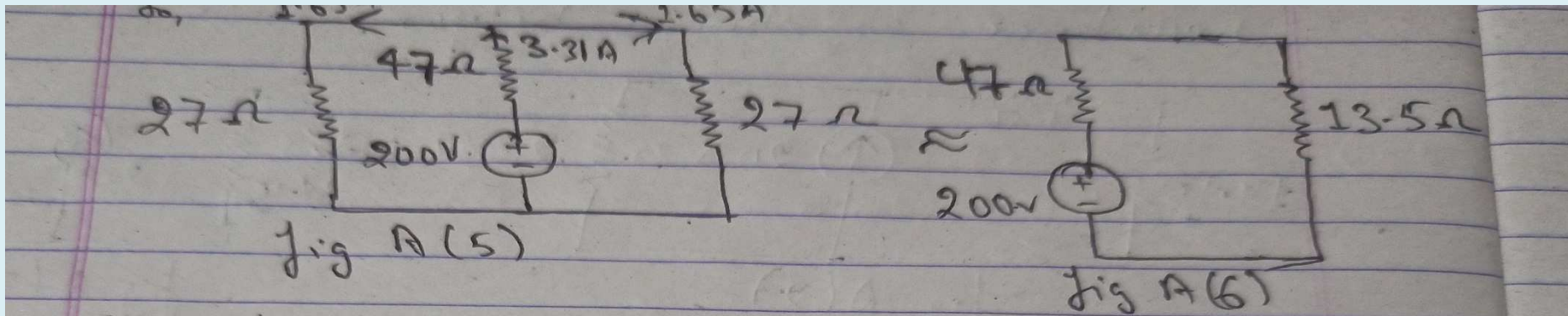


Fig A(6)

Circuit Theorem – Superposition Theorem



Now both the $27\ \Omega$ resistors are in parallel so equivalent resistance of these two resistors is $\frac{27}{2}\ \Omega = 13.5\ \Omega$

Now $47\ \Omega$ and $13.5\ \Omega$ are in series.

$$\text{So } R_{eq} = (47 + 13.5)\ \Omega = 60.5\ \Omega$$

$$\begin{aligned} \text{Current deliver by } 200\text{V source} &= \frac{200}{60.5}\ \text{A} \\ &= 3.31\ \text{A} \end{aligned}$$

This current will equally divide in 2 parts as the resistance in both branch is equal i.e. $27\ \Omega$ as shown in fig A(5)

Circuit Theorem – Superposition Theorem

As $27\ \Omega$ in one branch is due to $(4+23)\ \Omega$
So, the current through $23\ \Omega$ resistor is $1.65\ \text{A}$
due to the $200\ \text{V}$.

$$I''(23\ \Omega) = 1.65\ \text{A} \quad \text{--- (ii)}$$

Hence the total current due to sources $200\ \text{V}$ & $20\ \text{A}$ in the $23\ \Omega$ resistor ~~is given~~ can be obtained by adding eqn. (i) & (ii)

$$I(23\ \Omega) = I'(23\ \Omega) + I''(23\ \Omega)$$

$$= (9.58 + 1.65)\ \text{A} = 11.23\ \text{A}$$

Circuit Theorem – Superposition Theorem

For any query contact at “9771474020”.

Thank You