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

By:

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Circuit 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

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

These Network Theorems are:-

a. Superposition Theorem
b. Thevenin's Theorem
c. Norton's Theorem
d. Maximum Power Transfer
e. Reciprocity Theorem
f. Star-Delta Transformation

Circuit Theorem

a. <u>Superposition Theorem :-</u>

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

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.

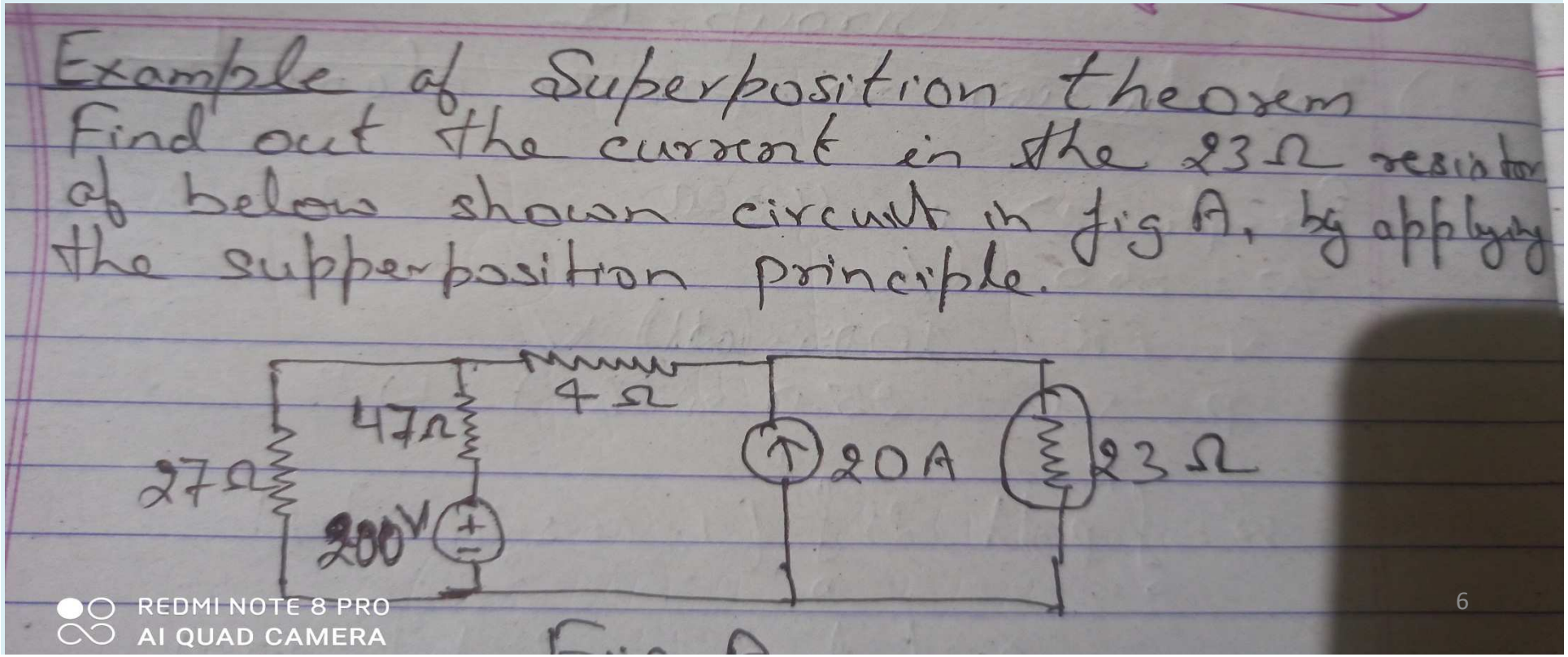
5) Now consider the other source and repeat the steps from 2 to 4.

Circuit Theorem

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

Fig A.

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 ~~supper~~ superposition theorem in above ckt we can take any one of the source 1st. Here let us take current source and the draw the ckt again as below.

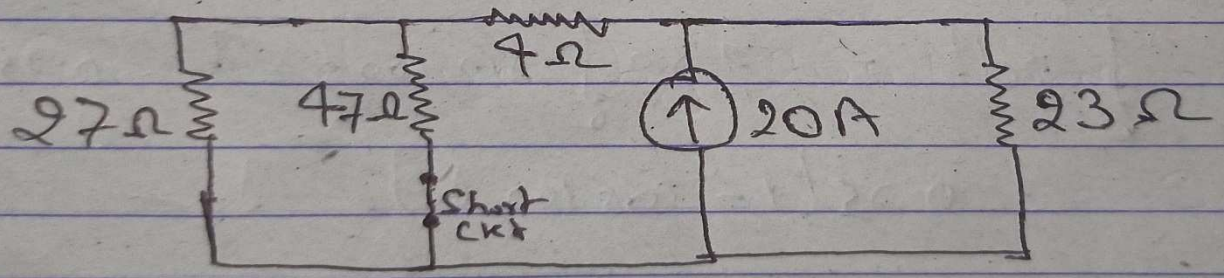


fig A(1)

We consider current source first, so voltage

Circuit Theorem

source has been short circuited as mentioned in step 2.

When we short circuited the voltage source then resistance 27Ω and 47Ω are in ||rl.

So,

$$R_{||rl} = \frac{27 \times 47}{(27+47)}\ \Omega = 17.15\ \Omega$$

Now this ||rl resistance is in series with 4Ω resistance as shown below.

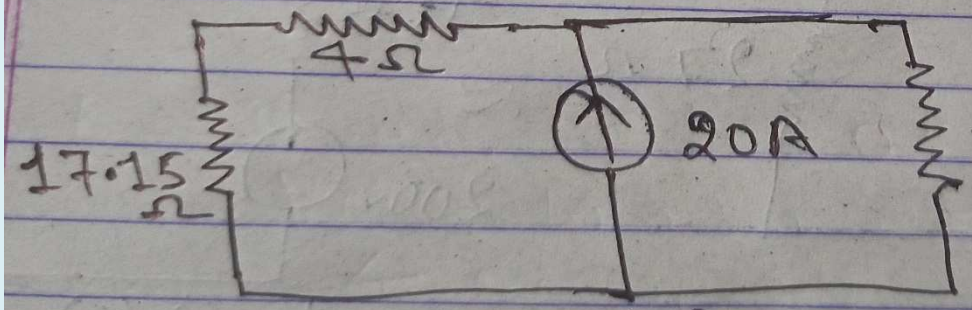


fig A(2)

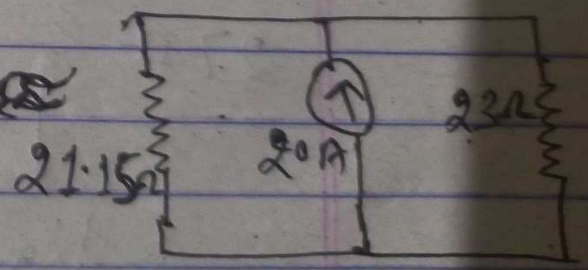


fig A(3)

Circuit Theorem

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

Now the ~~the~~ current source is of 20A so it will delivers 20A current which will be divide among 23Ω & $21.15\,\Omega$ resistor.

So current in 23Ω resistor due to 20 A source is

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

Now considering the voltage source 200V and find the current in $23\,\Omega$ resistor due to 200V. This time open circuit the current source as shown in fig A(4)

Circuit Theorem

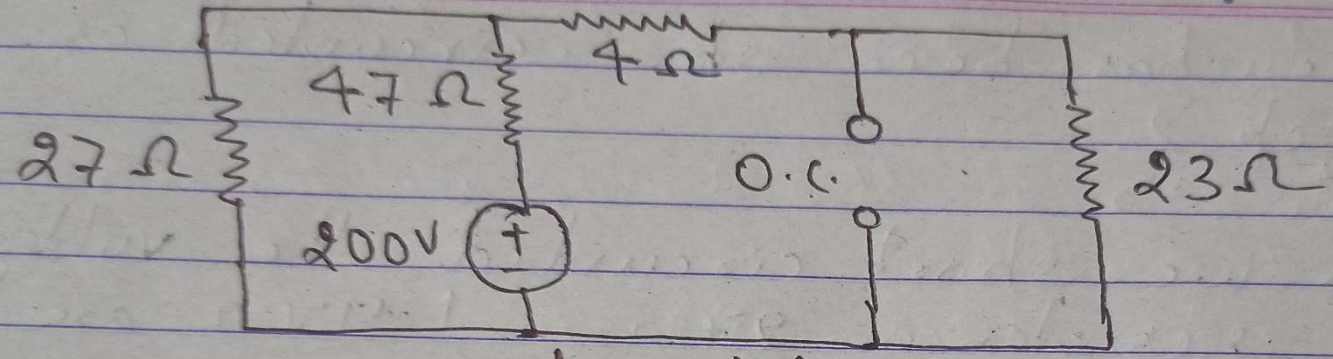


fig A(4)

Now, 23 Ω resistance & 4 Ω are in series so,

$R_{series} = (23+4)\,\Omega = 27\,\Omega$

So,

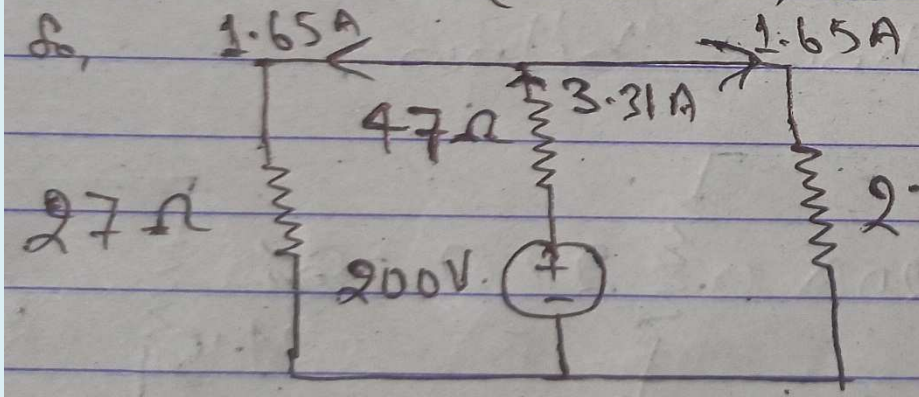


fig A(5)

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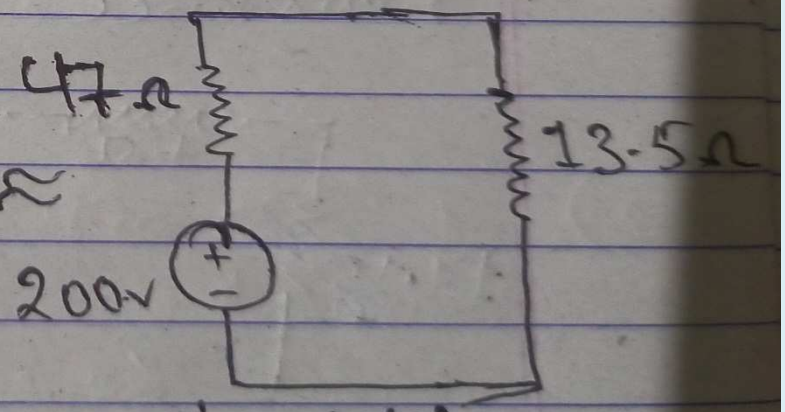

fig A(6)

Circuit Theorem

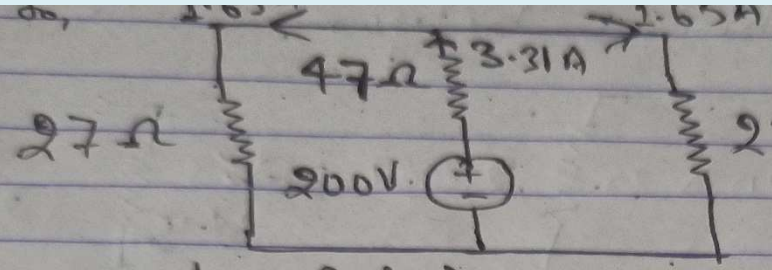

fig A(5)

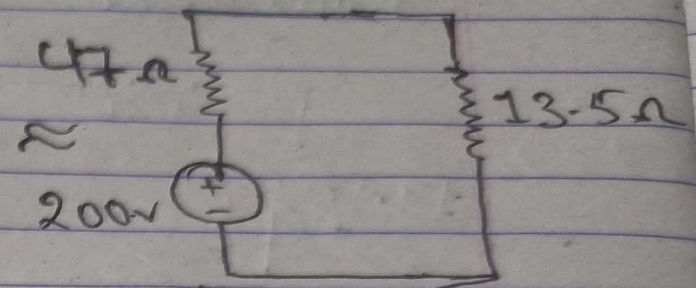

fig A(6)

Now both the 27 Ω resistor are in ||el so equivalent resistance of these two resistor is $\frac{27}{2}\,\Omega = 13.5\,\Omega$

Now 47 Ω and 13.5 Ω are in series.

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

Current deliver by 200V source $= \frac{200}{60.5}$ A

$= 3.31$ A

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

Circuit Theorem

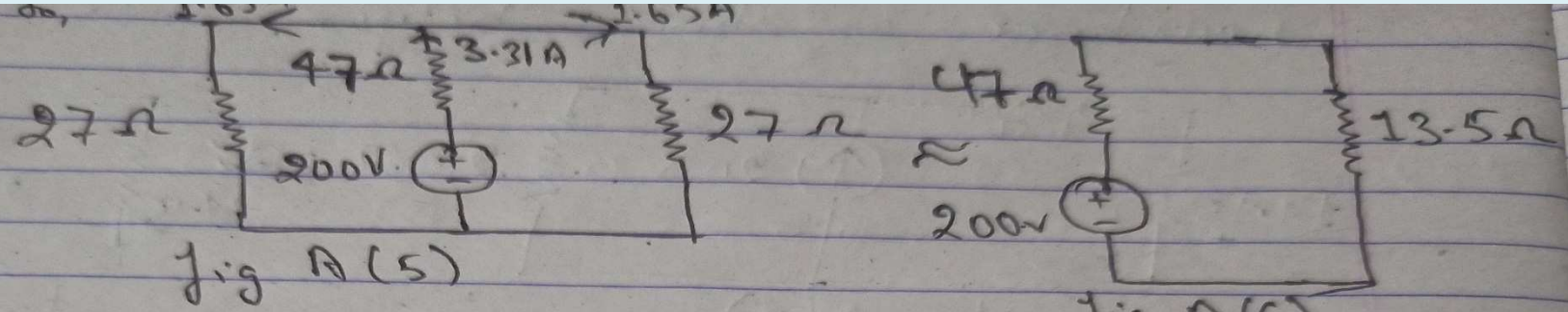

fig A(5) fig A(6)

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