# Paper 1, TDC Part-1
# Chapter– 4, Circuit Theorems
# Lecture - 12


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# Circuit Theorem

Let us see some problems on Star-delta transformation.

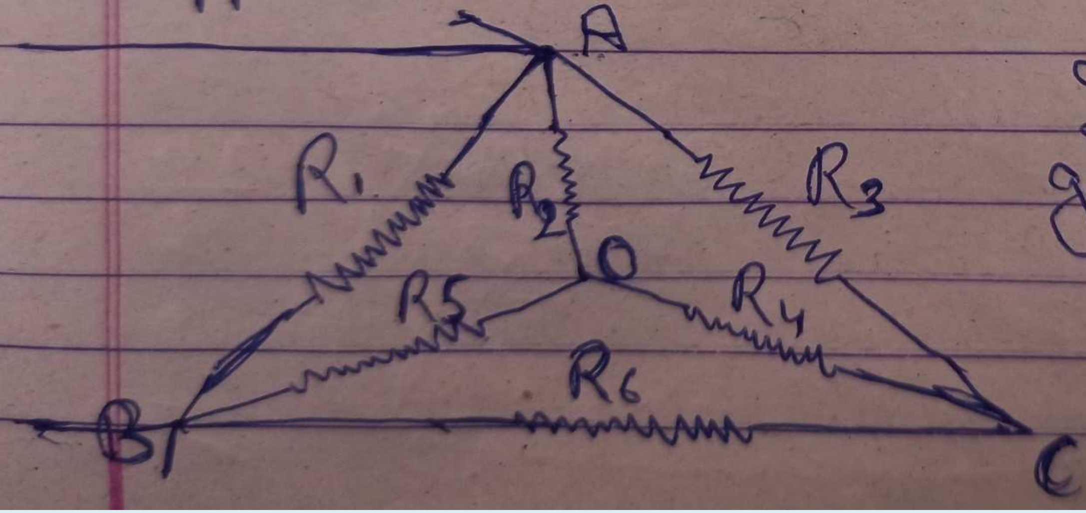
Whenever we deal with star or delta connection during analysis of circuit we will must follow the following steps.

1.) While analysing any network first we have to solve series & ||rl combination of resistors. Without solving series & ||rl combination we ~~will sho~~ should not do any transformation i.e. either "Star to Delta" transformation or "Delta to Star" transformation.

# Circuit Theorem

Once we resolve series & parallel combination then we do required transformation.

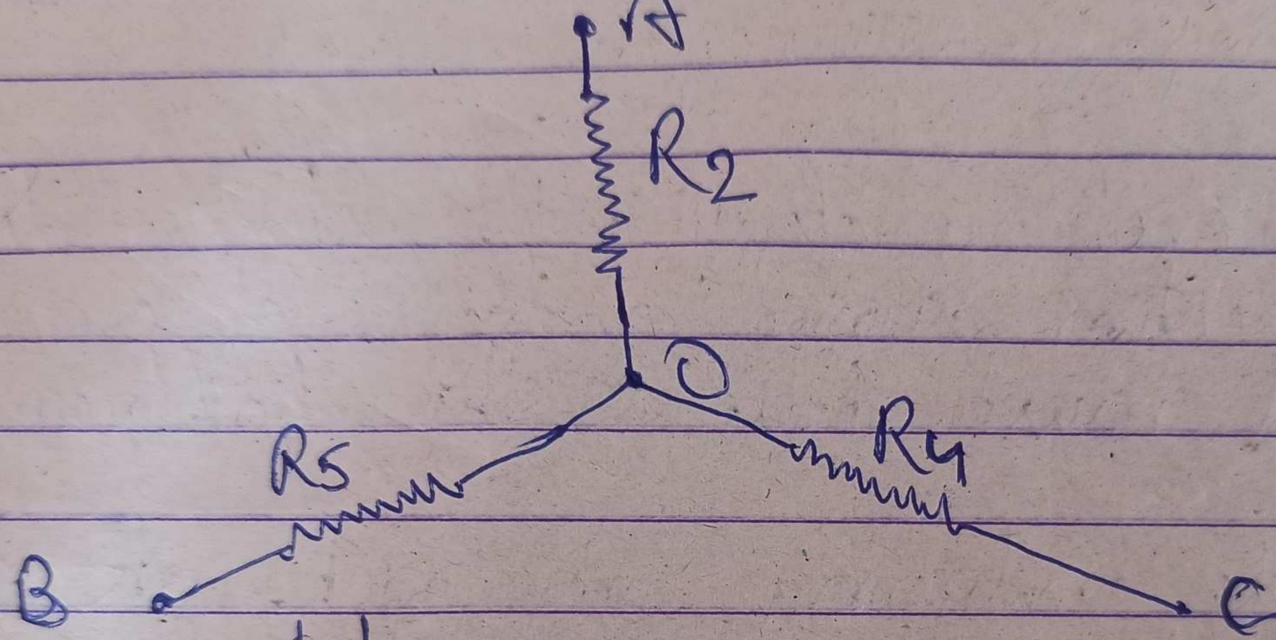
2.) Whenever we deal with 3 delta at a time then we should should solve the star i.e. transform the star to delta which appear between the 3 delta.




In figure of the given network we have 3 delta, AOB, AOC, BOC

# Circuit Theorem

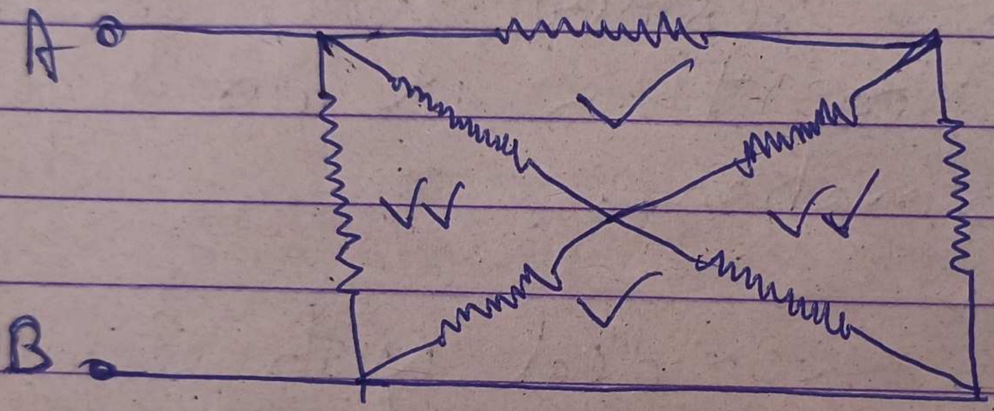
We can see the star, between the delta




We will 1st transform this star to delta then solve the network.

# Circuit Theorem

3) If there are 4 delta at a time in a n/w we will then solve two opposite delta at a time.




So here we solve either single tick delta at a time or double tick delta at a time.

# Circuit Theorem

Example: Find the equivalent resistor between terminal A & B of the network given in figure 1(a).

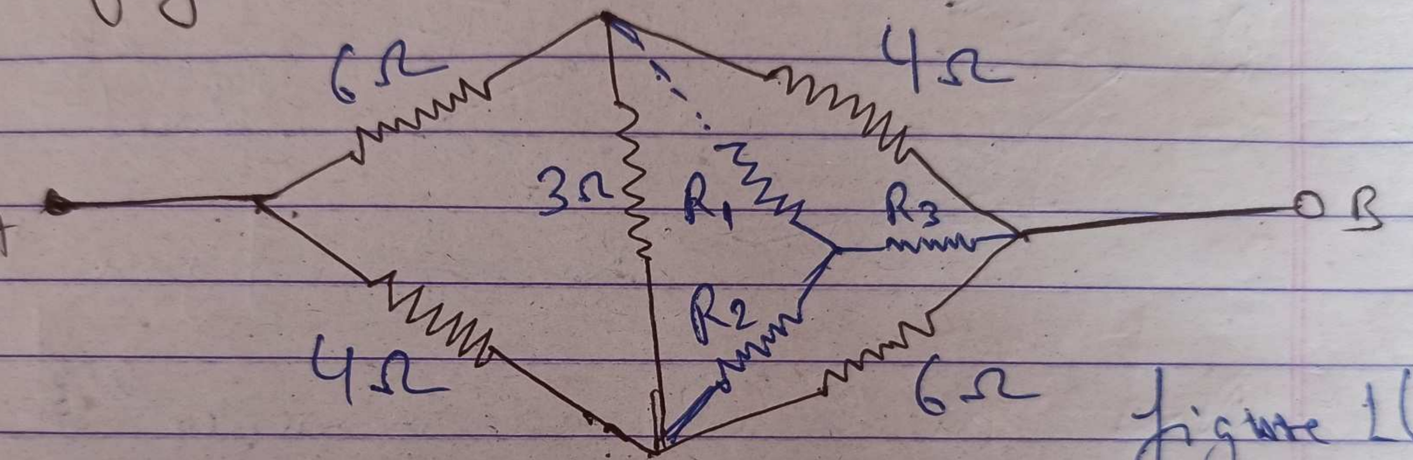



figure 1(a)

Soln. In in the given figure we can see that there is no combination of series and ||el resistor. There are 2 delta connection of resistor. So to find equivalent resistance between terminal

# Circuit Theorem

connection of resistor, so to find equivalent resistance between terminal A & B we transform any one of the delta to star connection. let us transform the delta connection of right side i.e. towards terminal B.

Now using the formula of delta to star transform we find the equivalent resistor $R_1$, $R_2$ & $R_3$ as,

$$R_1 = \frac{3 \times 4}{3+4+6} = \frac{12}{13}\,\Omega \; ; \; R_2 = \frac{3 \times 6}{13} = \frac{18}{13}\,\Omega$$

$$R_3 = \frac{4 \times 6}{13} = \frac{24}{13}$$

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# Circuit Theorem

Now drawing the N/w with star connection

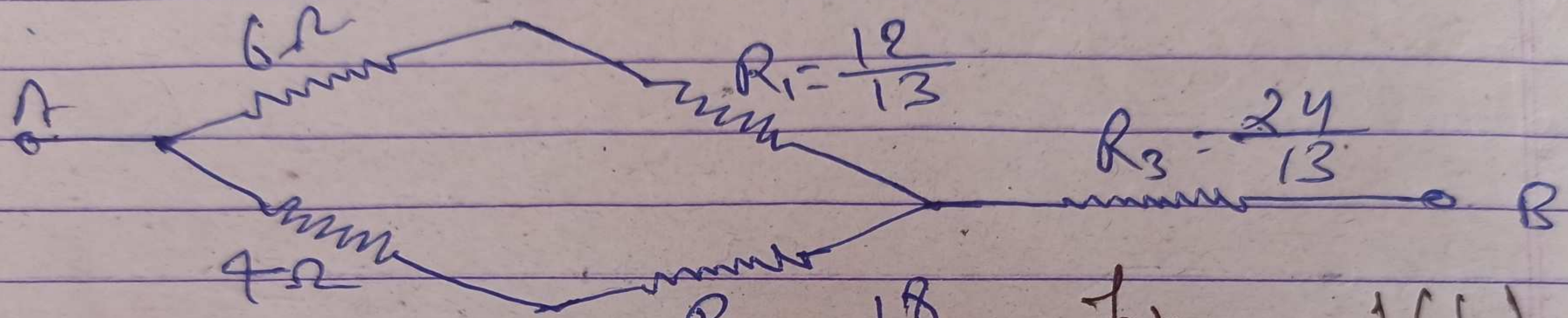
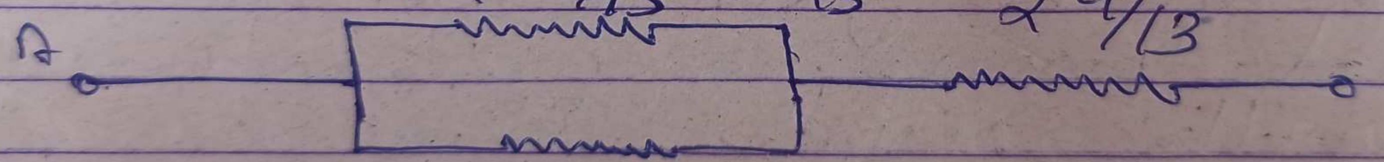



Figure 1(b)

Now $R_1$ & 6Ω are in series and $R_2$ & 4Ω are in series. So

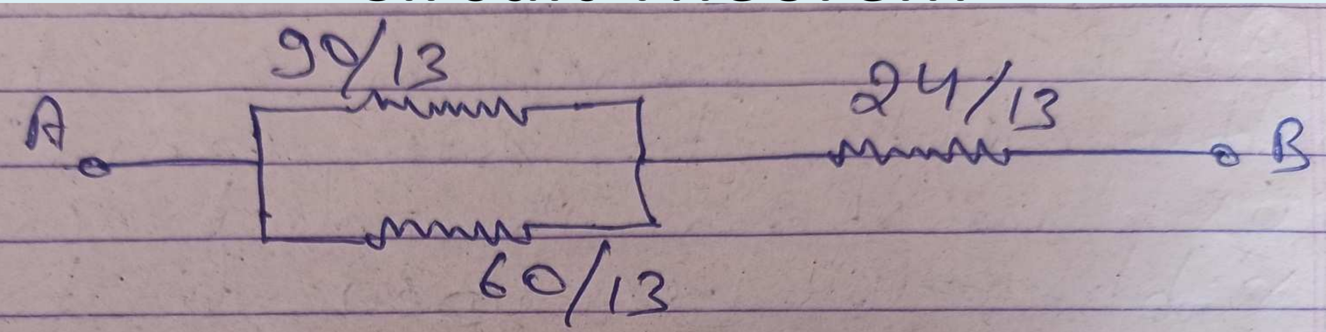
$$6 + 12/13 = \frac{78+12}{13}$$




$$4 + \frac{8}{13} = \frac{52+8}{13} = \frac{60}{13}$$

# Circuit Theorem

or




Equivalent resistor between terminal A & B is,

$$R_{eq} = \left(\frac{90}{13} \parallel \frac{60}{13}\right) + \frac{24}{13}$$

$$= \frac{\frac{90}{13}\times\frac{60}{13}}{\frac{90+60}{13}} = \frac{90\times 60}{13\times 150} + \frac{24}{13}$$

$$R_{eq} = \frac{36}{13} + \frac{24}{13} = \frac{60}{13}\ \Omega$$

# Circuit Theorem

**Problem 2:-** Find Req between terminal A & B of the n/w shown in figure 2(a).

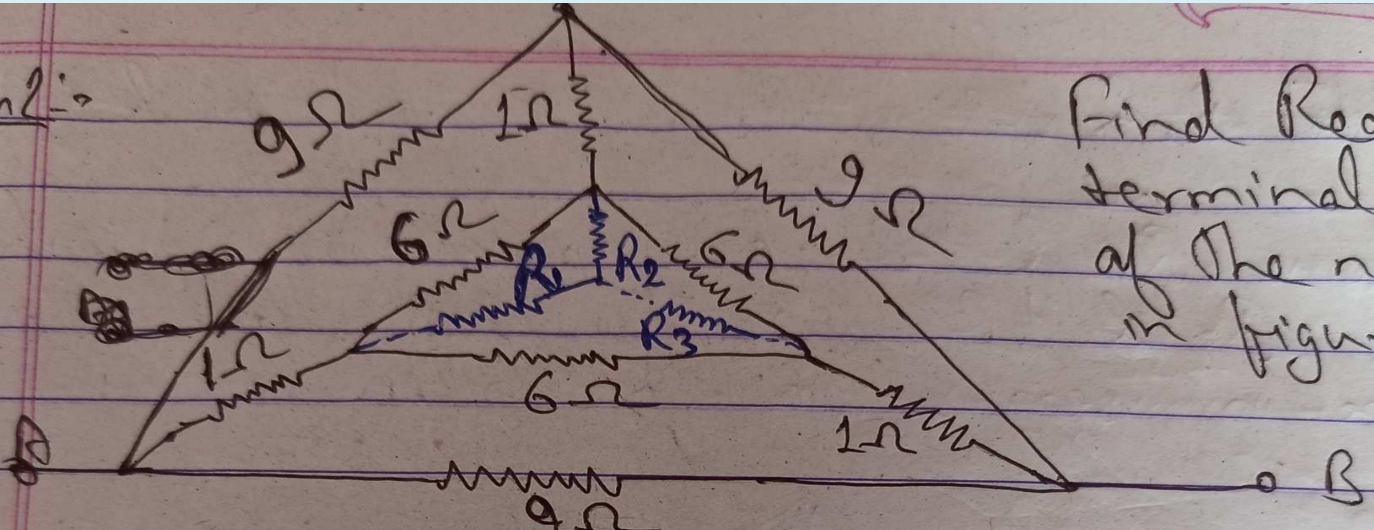



Figure 2(a)

**Soln:-** In the given n/w of figure 2(a) we have two delta connection one is inside and other is out side. There is no series & ||el connection of resistor. To find Req we will transform delta of inside into star connection, so,

# Circuit Theorem

$$R_1 = \frac{6 \times 6}{6+6+6} = \frac{36}{18} = 2\Omega = R_2 = R_3$$

As all arm contain resistors of same value so $R_1 = R_2 = R_3 = 2\Omega$.

Now the N/w will be

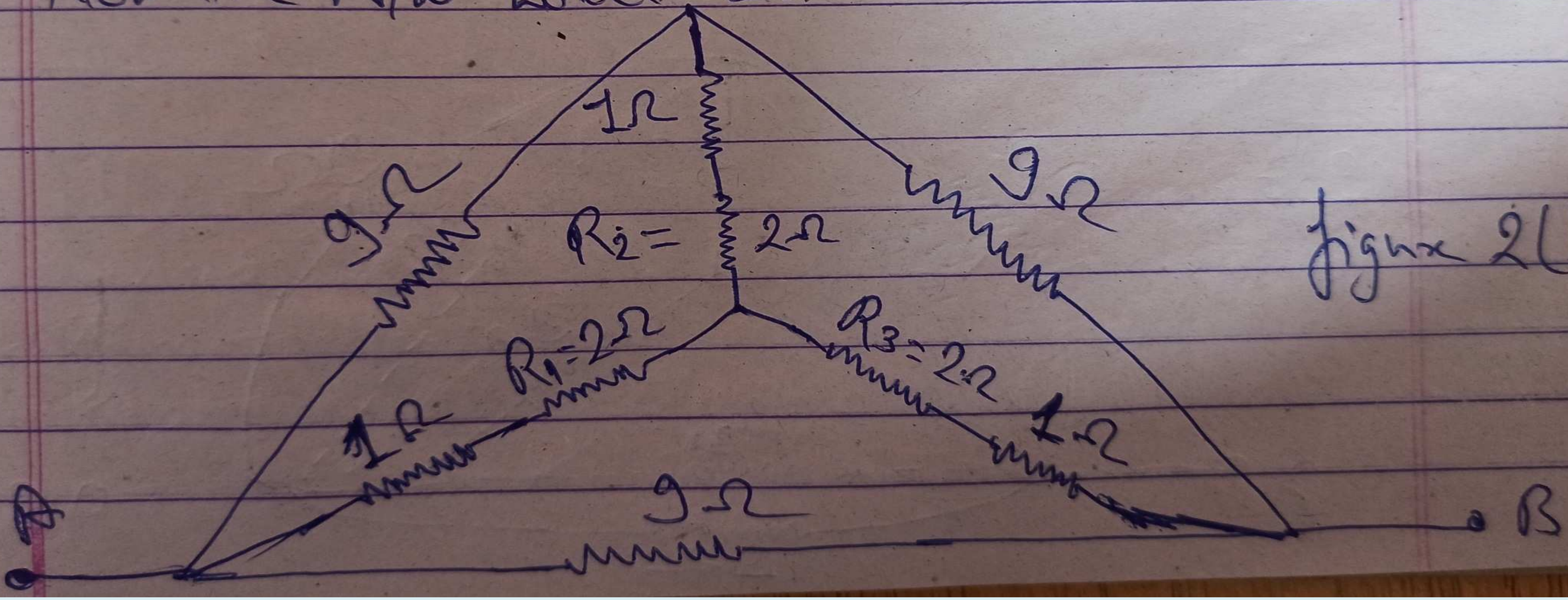



figure 2(b)

# Circuit Theorem

Now $R_1$ & 1Ω are in series, similarly,
$R_2$ & 1Ω " " " and $R_3$ & 1Ω
are in series. so the n/w is.

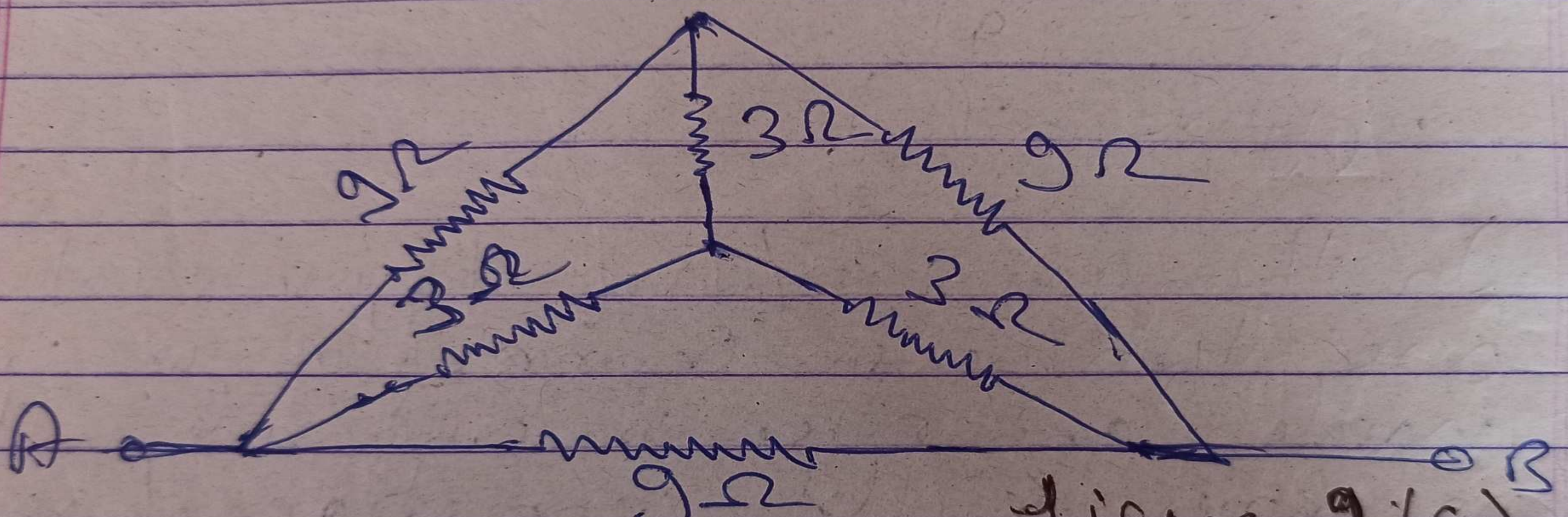



figure 2(c)

Now again there is no any series or ||rl
connection. Here we can say that there
are 3 delta connection or 1 delta

# Circuit Theorem

Now again there is no any series or ||el connection. Here we can say that there are 3 delta connection or 1 delta connection outside and 1 star connection inside delta connection.

Here we will transform inner star connection into delta connection.

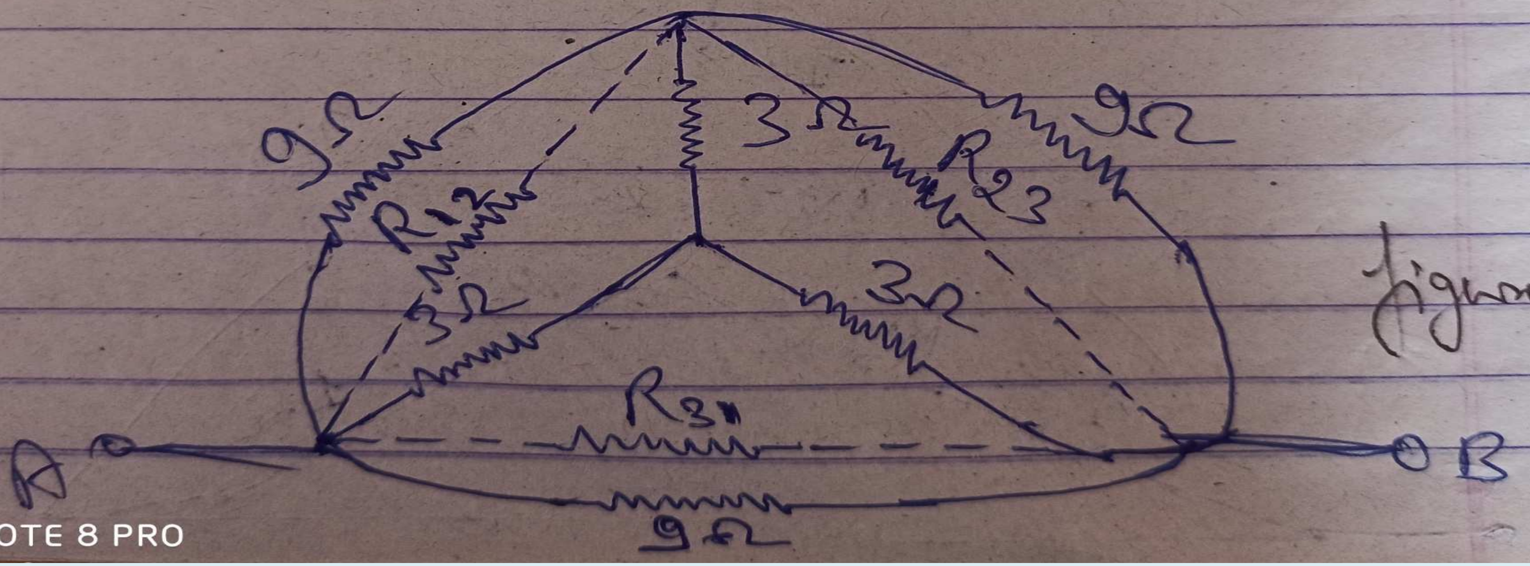



figure 2(d)

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# Circuit Theorem

$$R_{12} = \frac{3\times 3 + 3\times 3 + 3\times 3}{3} = \frac{27}{3} = 9\Omega$$

Since all arm have the resistance of same value so,

$$R_{12} = R_{23} = R_{31} = 9\Omega$$

Now the n/w can be drawn like.

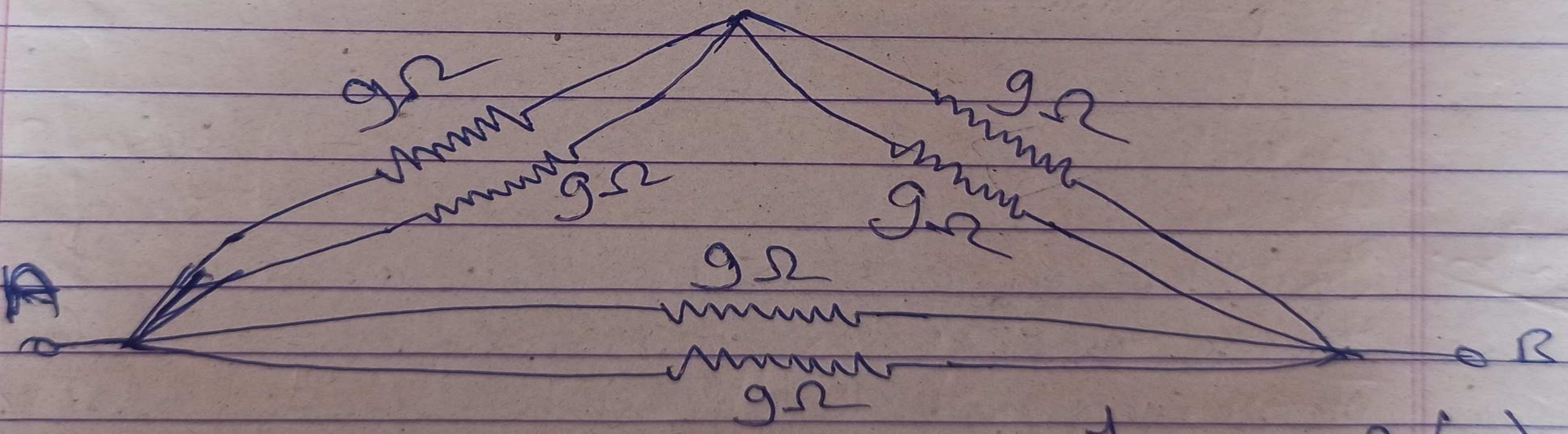


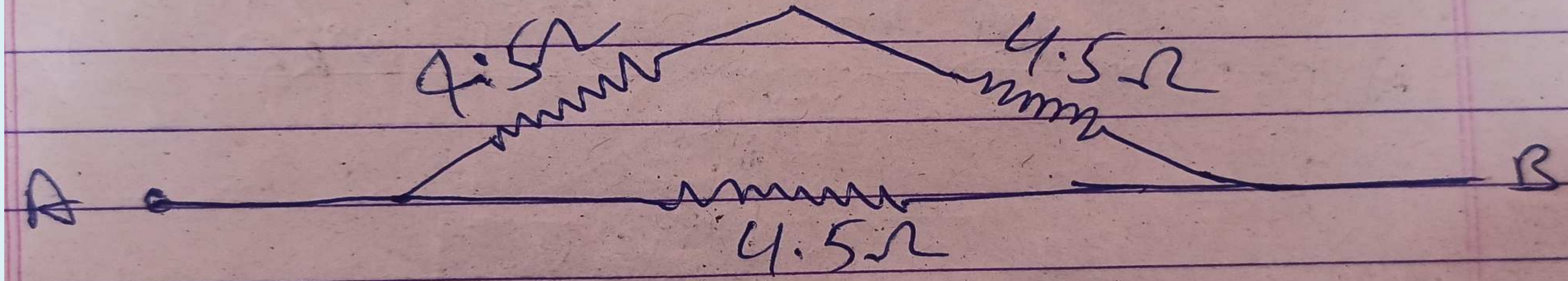

figure 2(e)

# Circuit Theorem

figure 2(e)

Now there are 3 ||al connection of 9 Ω & 9 Ω resistor,

So $(9 \parallel 9) = \frac{9 \times 9}{18} = 4.5\ \Omega$




$R_{eq} = (4.5 + 4.5)\Omega \parallel 4.5\ \Omega$

$R_{eq} = 9\ \Omega \parallel 4.5\ \Omega = \frac{9 \times 4.5}{13.5} = 3\ \Omega$

# Circuit Theorem

**Example 3.** Find the current in the 17 Ω resistors in the network shown in figure 3(a) using star - delta transformation.

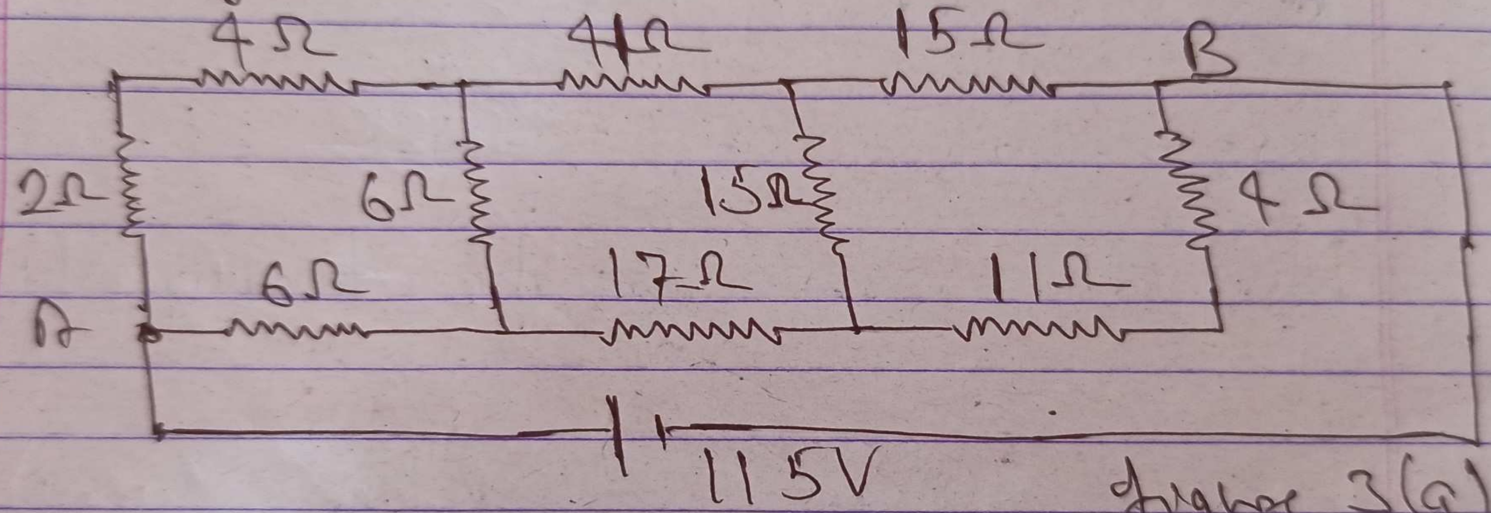
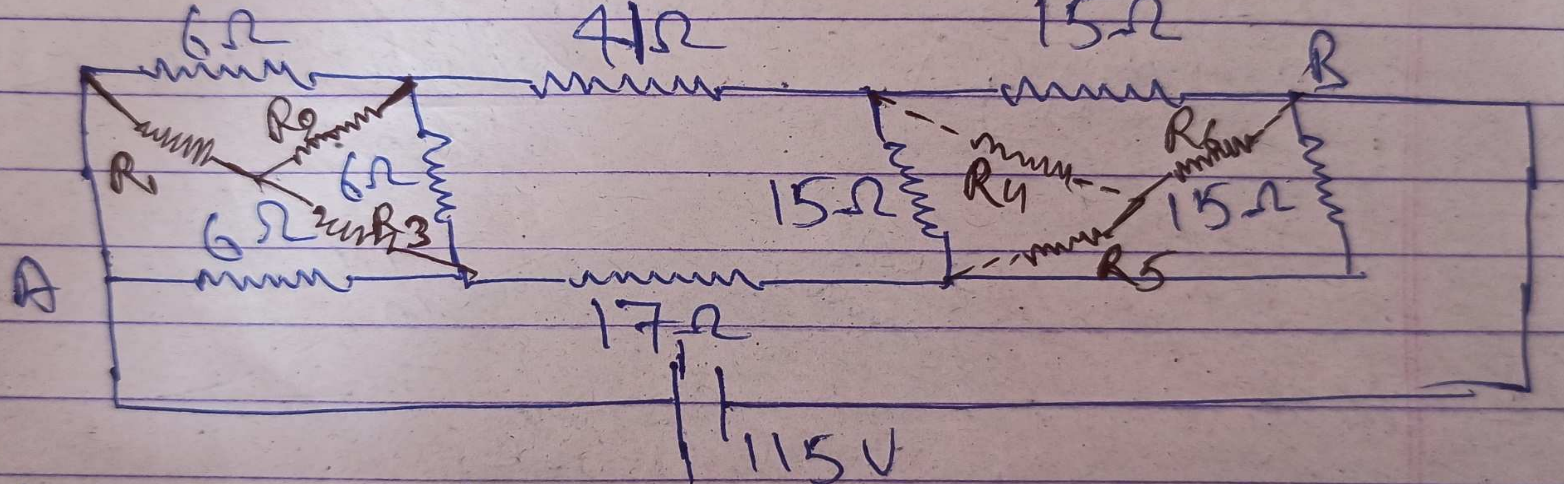



figure 3(a)

**Soln:** In the given n/w we observe that there series combination 2 & 4Ω are in series at left side and 4Ω & 11Ω are in series at right side so the

# Circuit Theorem

these are series combination 2 & 4Ω are in series at left side and 4Ω & 11Ω are in series at right side so the n/w can be redrawn as,




We have 2 delta connections in the n/w or 4 star connections. let us consider 2 delta connection and transforming this two delta connection to star connection

# Circuit Theorem

for 1st delta with 6Ω resistor each, equivalent star connection will have resistor value as,

$$R_1 = R_2 = R_3 = \frac{6 \times 6}{6+6+6} = \frac{36}{18}\,\Omega = 2\Omega$$

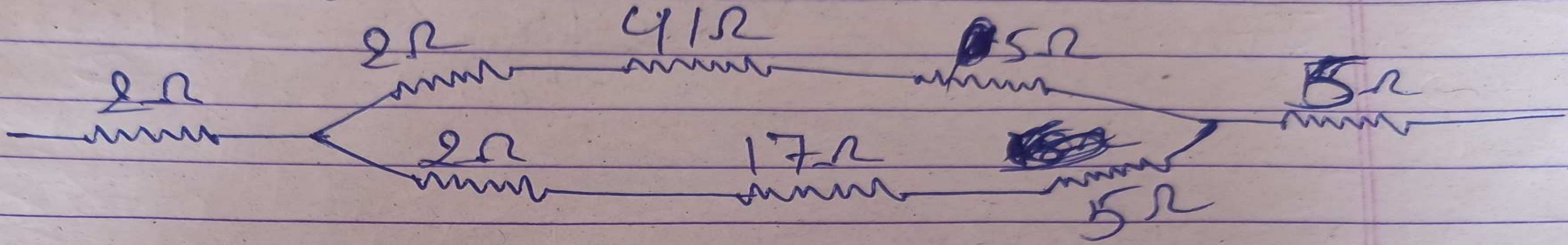
Illy for 2nd delta with 15Ω resistor each, equivalent star connection will have

$$R_4 = R_5 \pm R_6 = \frac{15 \times 15}{15+15+15} = \frac{15 \times 15}{45} = 5\Omega$$

Now the ckt. is like

# Circuit Theorem

Now the ckt. is like.

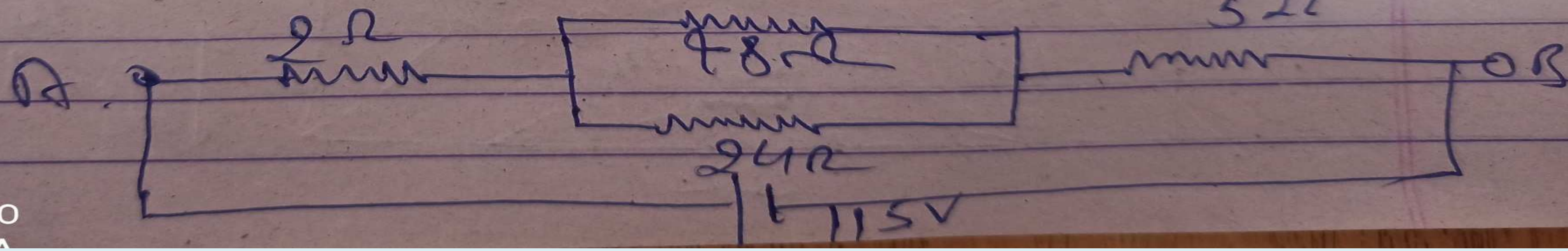



Now, 2Ω, 41Ω & 5Ω are in series so

$(2+41+5) = 48\Omega$

and also, 2Ω, 17Ω & 5Ω are in series so,

$(2+17+5)\Omega = 24\Omega$



# Circuit Theorem

$$R_{eq} = 2 + (24 \| 48) + 5\ \Omega$$

$$= 2 + \frac{24 \times 48}{(24+48)} + 5\ \Omega$$

$$R_{eq} = 23\ \Omega$$

$$I_{total} = \frac{115\ V}{23\ \Omega} = 5\ A.$$

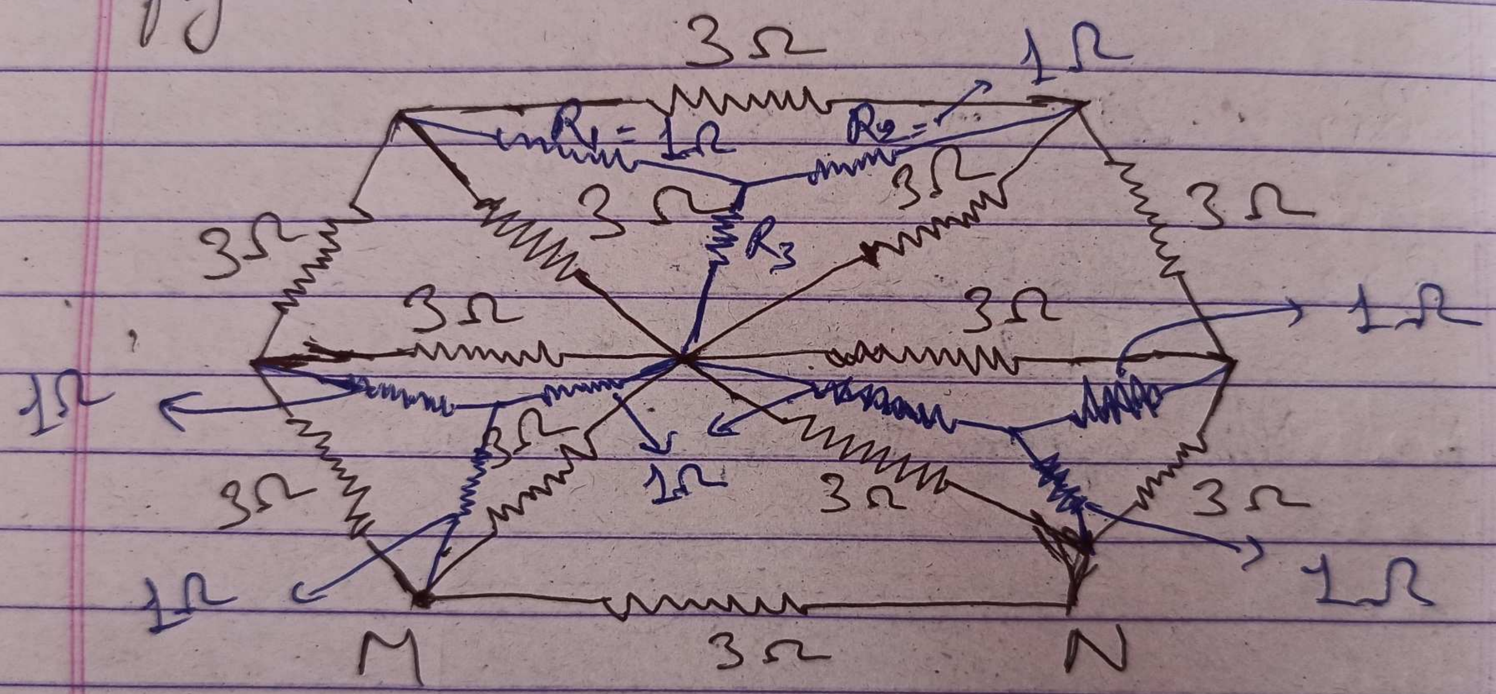
Current through 17 Ω resistor is current through the series connection of 2 Ω, 17 Ω and 5 Ω i.e. 24 Ω resistor.

$$I_{17} = I_{24} = \frac{5 \times 48}{(24+48)} = \frac{10}{3} = 3.33\ A$$

Ans.

# Circuit Theorem

Example 4) Find the total resistance between terminal MN of the n/w shown in figure 4(a)




Soln: Here we can observe that there is no

# Circuit Theorem

**Soln:** Here we can observe that there is no series & 11rd connection of resistors. There are 6 delta connections of resistors.

To analyse the ckt we will consider ~~any~~ 3 alternate delta at a time to transform into star connection.

As the value of all resistors are same so in ~~star~~ equivalent star connection the value of all resistors will be same for each star connection in each arm.

$$R_1 = R_2 = R_3 = \frac{3 \times 3}{3+3+3} = \frac{9}{9} = 1\Omega$$

# Circuit Theorem

Now the n/w can be drawn as below.

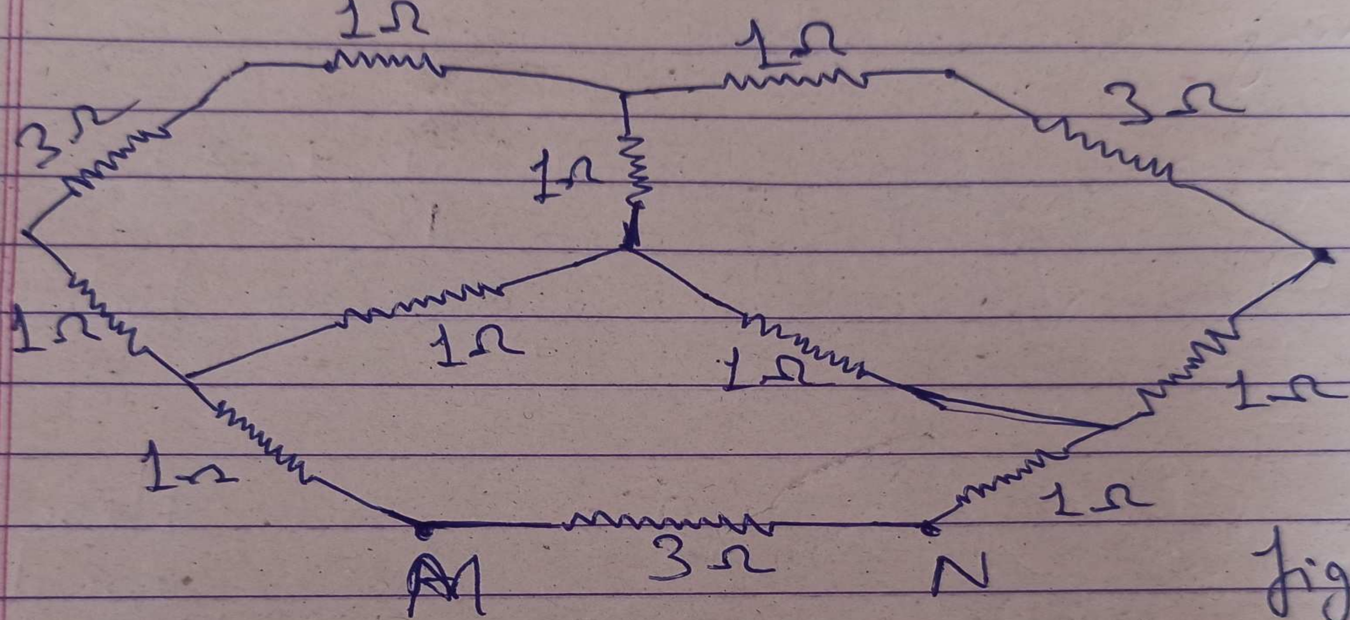



figure 4(b)

Now we have series combination of 1Ω, 3Ω & 1Ω resistor. These are 2 such connections. We will not consider series combination of the branch MN across which equivalent ~~seri~~ resistor to be find out.

# Circuit Theorem

connections. We will not consider series combination of the branch MN across which equivalent ~~seat~~ resistor to be find out.

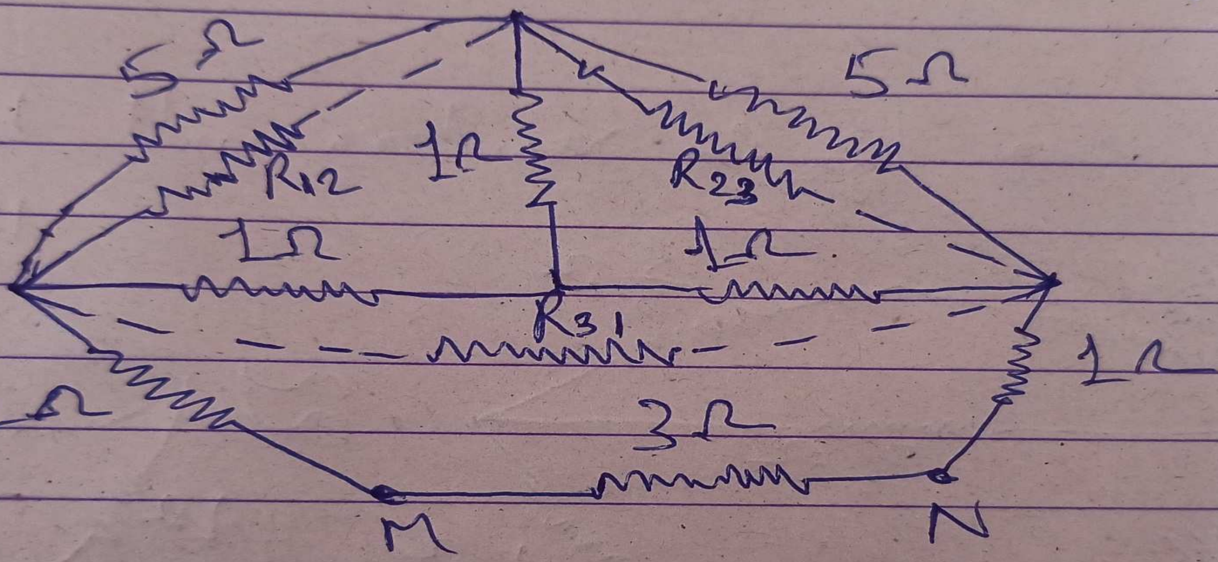



figure 4(C).

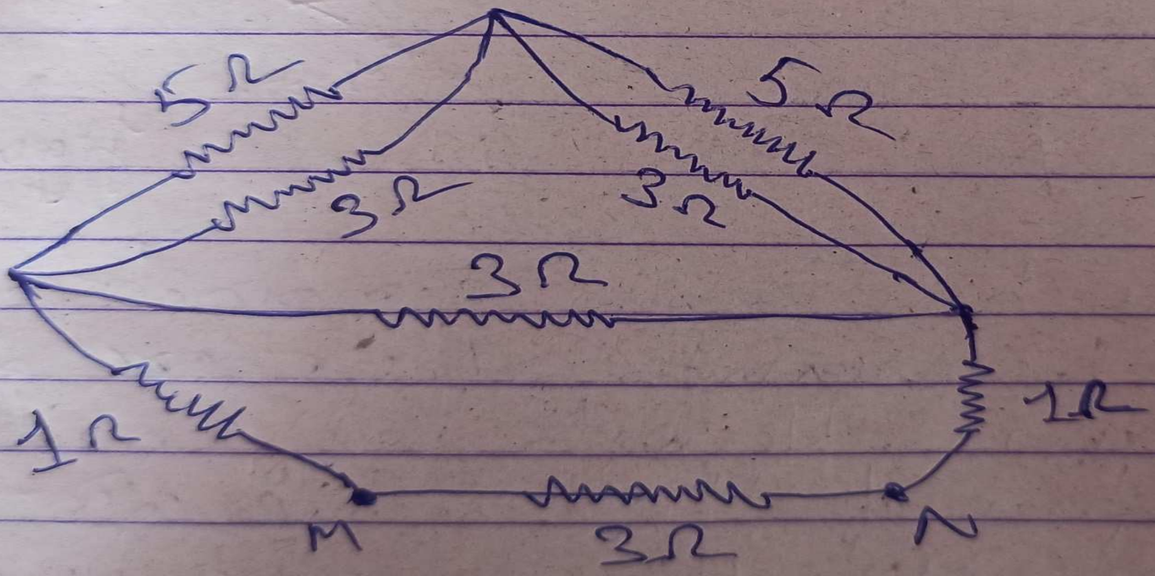
Now here we can observe a star connection inside the n/w. So we convert this star to delta connection. As each branch of star has 1Ω resistor so it's equivalent delta will have

# Circuit Theorem

delta connection with all three resistors having same value.

$$R_{12} = R_{23} = R_{31} = \frac{1\times1 + 1\times1 + 1\times1}{1} = 3\Omega.$$

Now the n/w can be drawn as below.

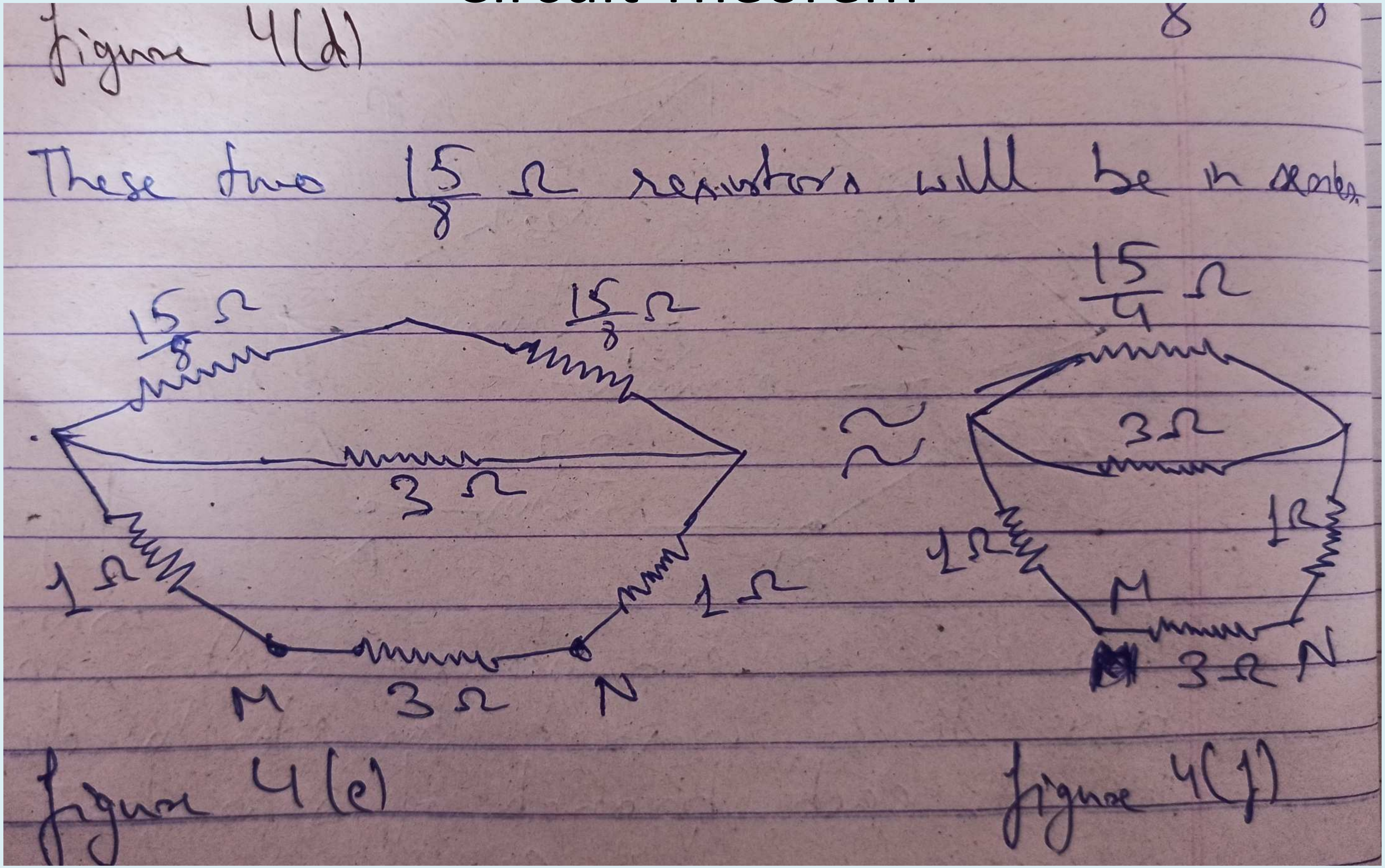



Here 5 & 3Ω are ||el and there are 2 such connecti

So $(5||3) = \frac{5\times3}{8} = \frac{15}{8}\Omega$

4(d)

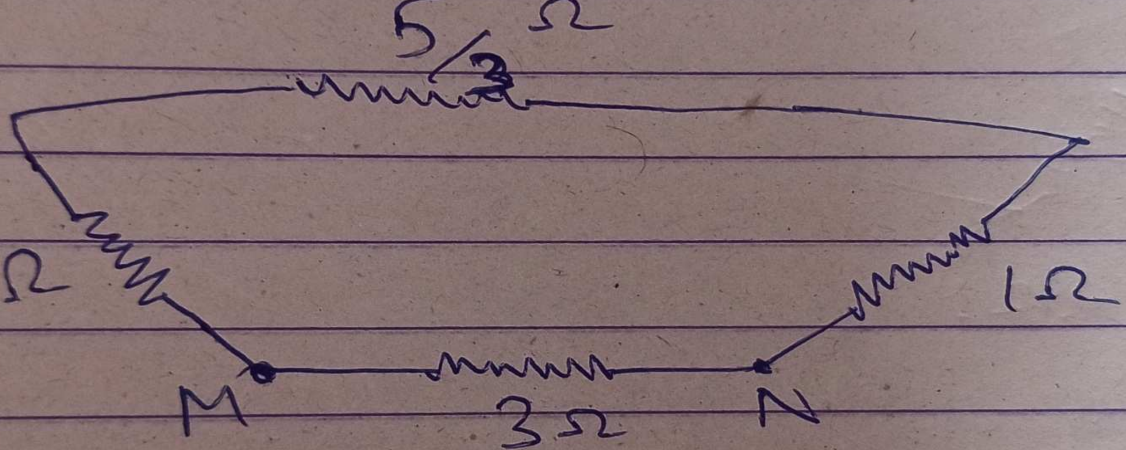
# Circuit Theorem



# Circuit Theorem

Now $\left(\frac{15}{4}\,\Omega \text{ \& } 3\Omega\right)$ are in ||el. So,

$$\frac{\frac{15}{4}\times 3}{\frac{15}{4}+3} = \frac{45/4}{27/4} = \frac{45}{27} = \frac{5}{3}$$

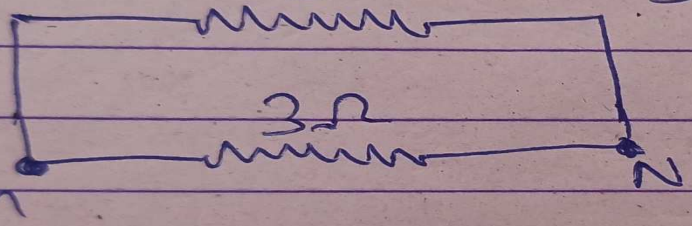



Now $\frac{5}{3}\,\Omega$, $1\Omega$ & $1\Omega$ will be series

# Circuit Theorem

Now $\frac{5}{3}\Omega$, $1\Omega$ & $1\Omega$ will be series as to find $R_{eq}$ for terminal M & N and this whole series combination is in ||el to $3\Omega$ of MN branch.

$$\frac{5}{3} + 2 = \frac{11}{3}\Omega$$




$$R_{eq} = \left(3\Omega \,||\, \frac{11}{3}\Omega\right) = \frac{3 \times 11/3}{3 + 11/3}$$

$$= \frac{11 \times 3}{20}$$

$$= \frac{33}{20}\Omega = 16{\cdot}5\Omega$$

# Circuit Theorem

In next lecture we start next chapter. For any query or problem discuss on What's App or contact on number available.

**THANK YOU**