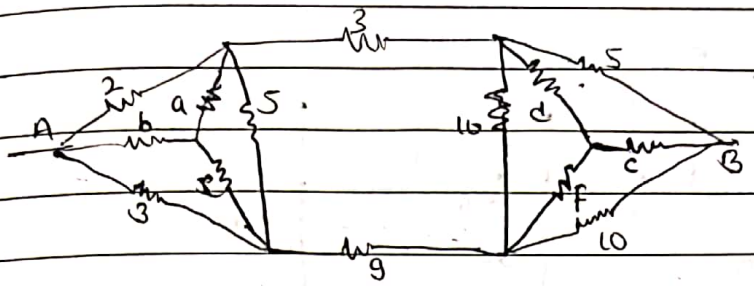
Star-delta
Tutorial -'3'

Q.1. Find the voltage to be applied across AB in order to drive a current of 5A into the circuit of figure 1 by using star delta transformation



Let a, b, c, d, e, f, be equivalent star connection of the two delta circuit shown.

$a = \frac{2\times5}{2+3+5} = 1\ \Omega$

$b = \frac{2\times3}{2+3+5} = \frac{3}{5}\ \Omega$

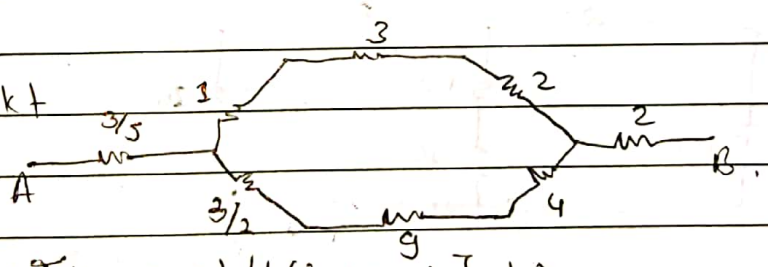
$c = \frac{5\times3}{2+3+5} = \frac{3}{2}\ \Omega$

$d = \frac{10\times5}{10+5+10} = 2\ \Omega$

$e = \frac{5\times10}{10+5+10} = 2\ \Omega$

$f = \frac{10\times10}{10+5+10} = 4\ \Omega$

Redrawing ckt



$R_{eq} = \frac{3}{5} + [(1+3+2) \,||\, (\frac{3}{2}+9+4)] + 2$

$= 3/5 + [6 \,||\, 4.5] + 2$

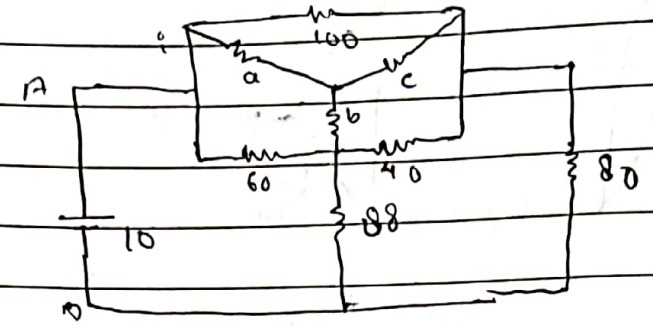
$= \frac{3}{5} + \frac{174}{41} + 2$

$= 6.843\ \Omega$

For 5A current $V_{AB} = IR = 5 \times 6.843$

$= 34.2\ V.$ #

2. Calculate the current I in the circuit & the resistance betn the terminals A & B as shown in fig. 2. by using star - delta transformation.

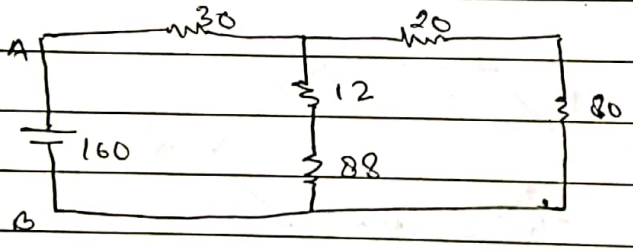


let a, b, c be equivalent star connection. Now,

$$a = \frac{100 \times 60}{100+60+40} = 30\,\Omega, \quad b = \frac{60 \times 40}{60+40+100} = 12\,\Omega$$

$$c = \frac{100 \times 40}{100+60+40} = 20\,\Omega$$

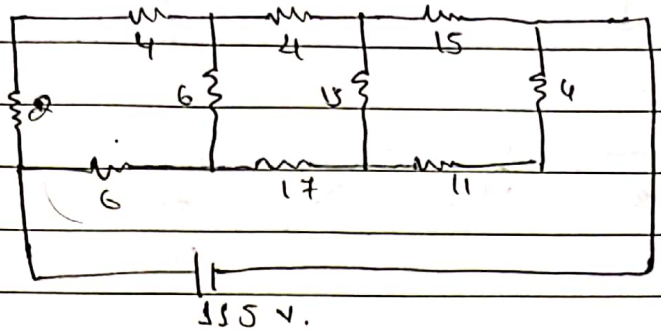
The ckt can be redrawn as



$$R_{eq} = [(80+20) \,||\, (12+88)] + 30$$
$$= [100 \,||\, 100] + 30$$
$$= \frac{100 \times 100}{100+100} + 30$$
$$= 80\,\Omega$$

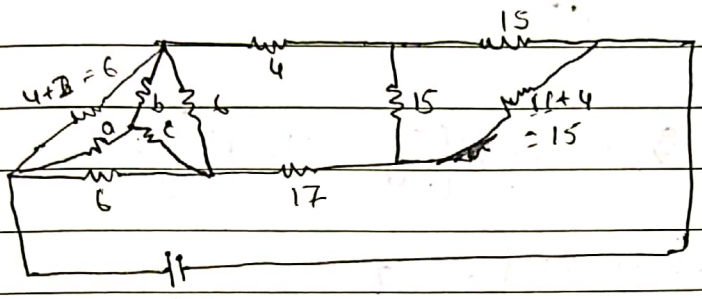
$$\text{Current } (I) = \frac{V}{R_{eq}} = \frac{160}{80}$$
$$= 2\,A$$

3. Find the current in 11Ω resistor using star delta conversion.



⇒ Soln,

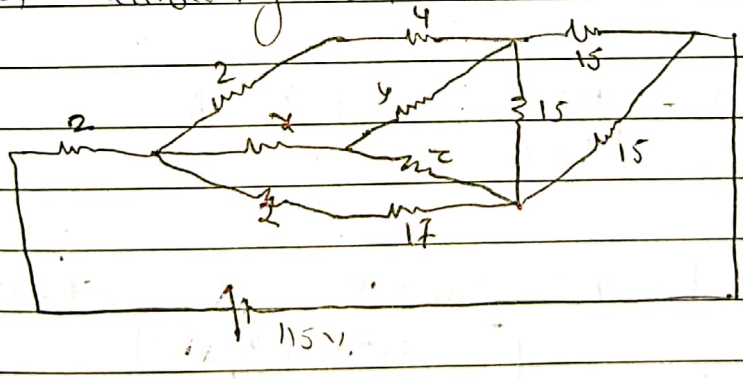
The ckt can be redrawn as:



using star delta

$$a = b = c = \frac{6 \times 6}{6+6+6} = 2\Omega$$

now, Redrawing ckt



Using star delta conversion

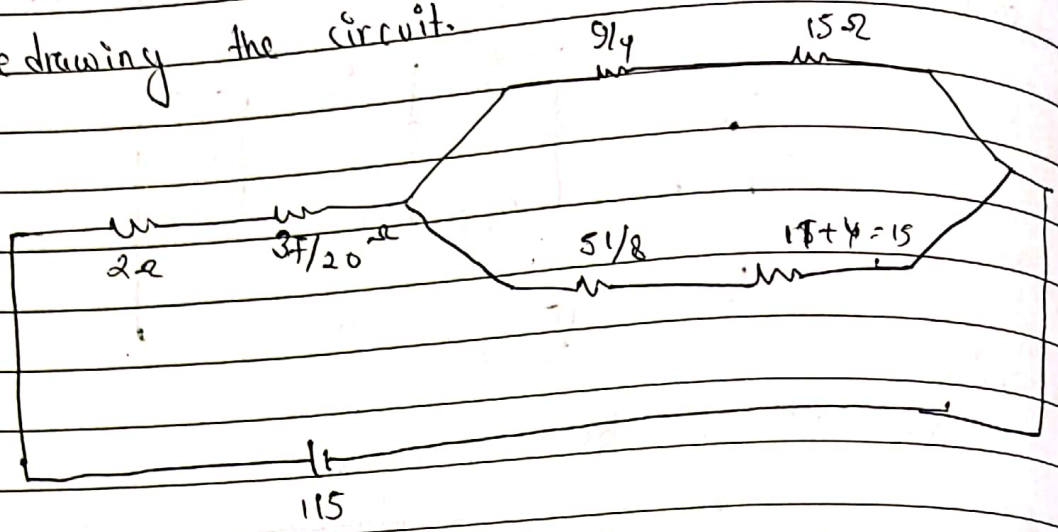
$$x = \frac{(4+2)(2+17)}{(4+2)(2+17)+15} = \frac{57}{20}\ \Omega$$

$$y = \frac{(4+2)\times 15}{(4+2)(2+17)+15} = \frac{9}{4}\ \Omega$$

$$z = \frac{15 \times (12+17)}{15+(2+17)\|(4+2)} = \frac{51}{8}\ \Omega.$$

(4)

Redrawing the circuit.



$$\text{Req.} = \left[\left(\frac{9}{4}+15\right) \| \left(\frac{51}{8}+11+4\right)\right] + \frac{57}{20} + 2$$

$$= \left[\frac{69}{4} \| \frac{171}{8}\right] + \frac{57}{20} + 2$$

$$= \frac{3933}{412} + \frac{57}{20} + 2$$

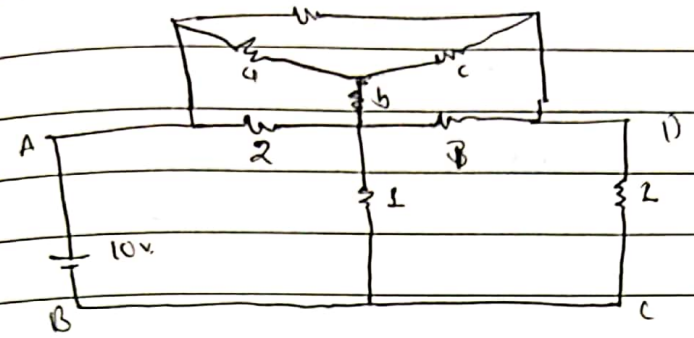
$$= 14.39\,\Omega$$

$$\text{Total current } (I) = \frac{115}{14.39} = 7.988\ A$$

$$\text{Current through } (I_{11}) = \frac{\frac{9}{4}+15}{\left(\frac{51}{8}+11+4\right)+\left(\frac{9}{4}+15\right)} \times 7.988$$

$$= 3.56\ A$$

4. In the circuit given in fig (4) calculate the amount through branch CD using star delta conversion.



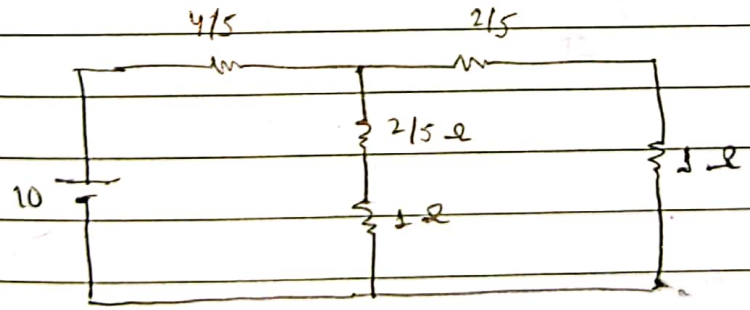
let a, b, c be equivalent star connection of delta connection 2Ω, 2Ω & 1Ω so

$$a = \frac{2\times2}{2+2+1} = \frac{4}{5}\ \Omega$$

$$b = \frac{2\times1}{2+2+1} = \frac{2}{5}\ \Omega$$

$$c = \frac{2\times1}{2+2+1} = \frac{2}{5}\ \Omega$$

The ckt can be redrawn as,



$$R_{eq} = \left[\left(\frac{2}{5}+1\right) \| \left(\frac{2}{5}+1\right) \right] + \frac{4}{5}$$

$$= \left[\frac{7}{5} \| \frac{7}{5} \right] + \frac{4}{5}$$

$$= \frac{\frac{7}{5}\times\frac{7}{5}}{\frac{7}{5}+\frac{7}{5}} + \frac{4}{5}$$

$$= \frac{7}{10} + \frac{4}{5} = 1.5\ \Omega$$

total current (I) = $\frac{V}{Req.}$

$= \frac{10}{1.5}$

$= 6.67\,A$

Using CDR,

$I_{ED} = \frac{2/5 + 1}{(2/5+1)(2/5+1)} \times 6.67$

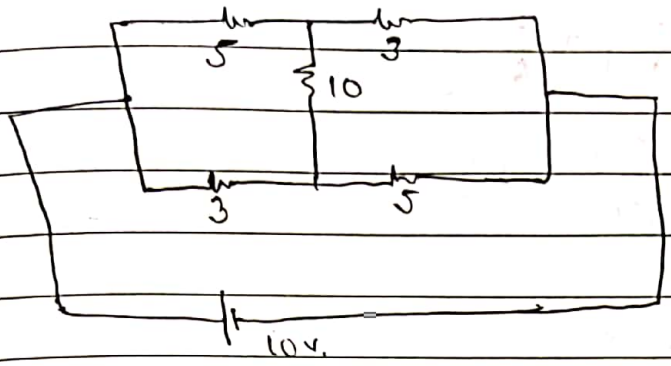
$= \frac{7/2}{7/2 + 7/2} \times 6.67$

$= \frac{7/2}{14/2} \times 6.67$

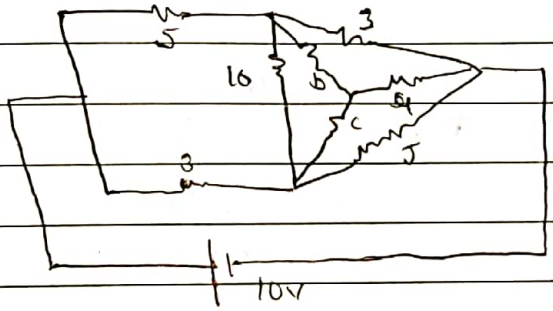
$= \frac{1}{2} \times 6.67$

$= 3.33\,A$

5. Find the current in 10 Ω resistor in fig 5. using star delta transformation.



The ckt can be redrawn as:



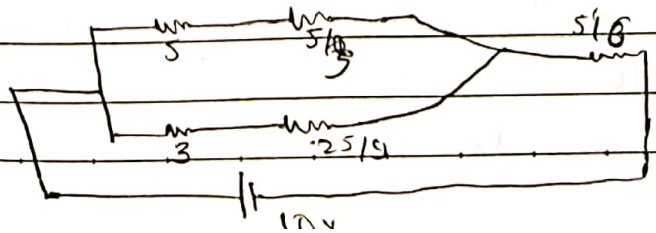
Changing the delta connection of 10 Ω, 3 Ω & 5 Ω into star connection.

$$a = \frac{3 \times 5}{3+5+10} = \frac{5}{6}\ \Omega$$

$$b = \frac{5}{3}\ \Omega$$

$$c = \frac{10 \times 5}{3+5+10} = \frac{25}{9}\ \Omega$$

The ckt can be redrawn as



$$R_{eq} = \left[\left(5+\frac{5}{3}\right) \| \left(3+\frac{25}{9}\right)\right] + \frac{5}{6}$$

$$= \left[\frac{20}{3} \| \frac{52}{9}\right] + \frac{5}{6}$$

$$= \frac{20/3 \times 52/9}{20/3 + 52/9} + \frac{5}{6}$$

$$= \frac{65}{21} + \frac{5}{6}$$

$$= 3.928\ \Omega$$

Total current $(I) = \frac{V}{R_{eq}} = \frac{10}{3.928}$

$= 2.54\ A$

Using CDR

$$I_1 = \frac{3+25/9}{(3+25/9)+(5+5/3)} \times 2.54$$

$= 1.179\ A$

$I_2 = 2.54 - 1.179$

$= 1.361\ A$

Applying KVL

$-5I_1 - 10I_{10} + 3I_2 = 0$

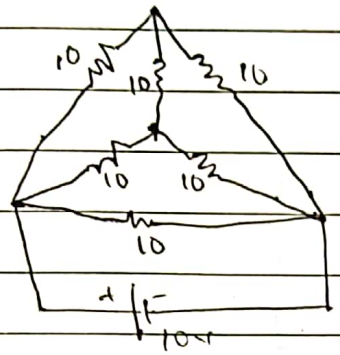
$-5(1.316) - 10I_{10} + 3\times(1.361) = 0$

$-10I_{10} = 1.8112.$

$I_{10} = -0.1812\ A$

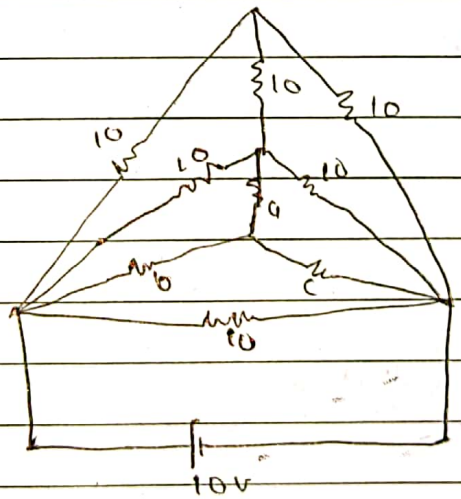
$I_{10} = 0.1812\ A\ (\downarrow)$.

6) Find the current supplied by the 10 V battery using star delta transformation.



=) Soln,

The ckt can be redrawn as:



Using star delta transformation.

$$a = \frac{10 \times 10}{10+10+10}$$

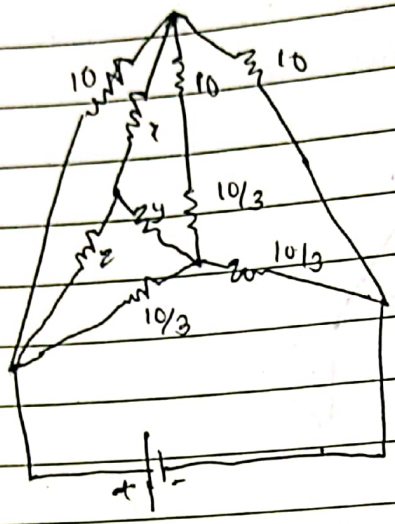
$$= \frac{10}{3}$$

Ily,

$$b = \frac{10}{3}$$

$$c = \frac{10}{3}$$

Redrawing the ckt



Aagain, using star-delta transformation.

$$y = \frac{\left(10 + 10 + \frac{10}{3}\right) \times \frac{10}{3}}{(10+10+\frac{10}{3}) + 10 + 10}$$

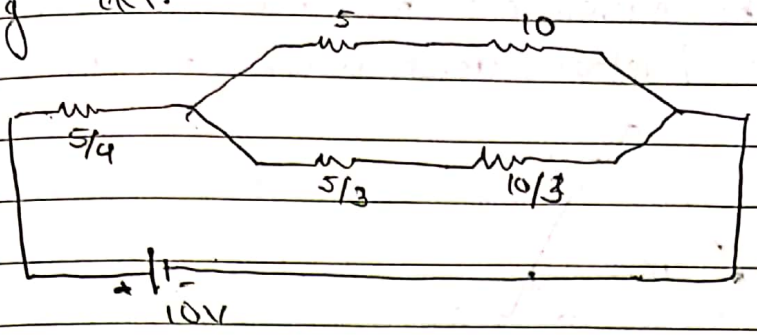
$$= \frac{5}{3}\ \Omega$$

$$x = \frac{10 \times \left(10 + 10 + \frac{10}{3}\right)}{(10+10+\frac{10}{3}) + \left(\frac{10}{3}\right) + 10} = 5\ \Omega$$

$$z = \frac{\frac{10}{3} \times 10}{10 + 10 + \frac{10}{3} + 10}$$

$$= 5/4\ \Omega$$

Redrawing ckt.



$$\text{Req} = \frac{5}{4} + \left[(5+10) \,||\, \left(\frac{5}{3} + \frac{10}{3}\right)\right]$$

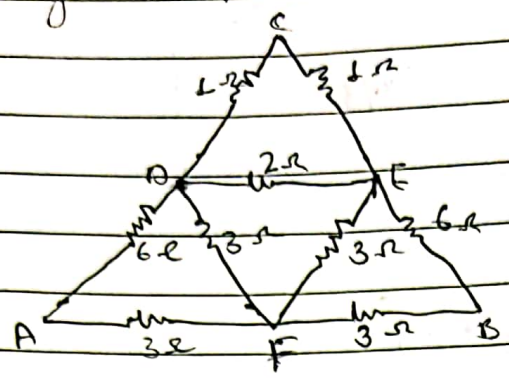
$$= \frac{5}{4} + [15 \,||\, 5]$$

$$= \frac{5}{4} + \frac{15}{4}$$

$$= 5$$

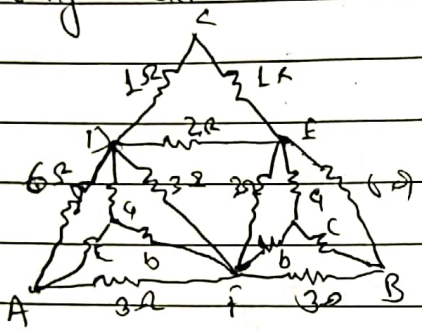
$$\text{Current } (I) = \frac{10}{5} = 2\ A$$

7) Calculate the equivalent resistance betⁿ points A & B by star / delta transformation in the circuit below.



⇒ Sol^n.

Redrawing ckt



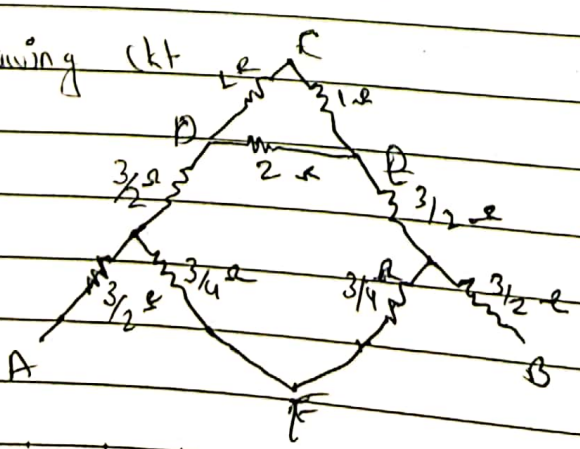
using star - delta transformation.

$$a = \frac{6\times 3}{6+3+3} = \frac{3}{2}\ \Omega$$

$$c = \frac{6\times 3}{6+3+3} = \frac{3}{2}\ \Omega$$

$$b = \frac{3\times 3}{6+3+3} = \frac{3}{4}\ \Omega$$

Redrawing ckt



$$R_{eq} = \left\{ \left[\left[(1+1) \| 2 \right] + \frac{3}{2} + \frac{3}{2} \right] \| \left(\frac{3}{4} + \frac{3}{4} \right) \right\} + \frac{3}{2} + \frac{3}{2}$$

$$= \left\{ \left[2 \| 2 \right] + 3 \| 3/2 \right\} + 3$$

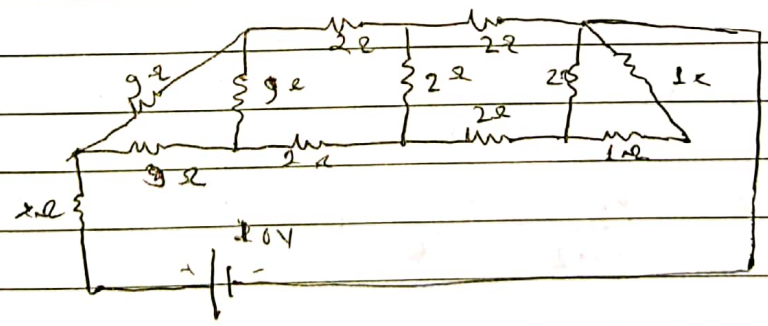
$$= \left\{ \frac{2 \times 2}{2+2} + 3 \| \frac{3}{2} \right\} + 3$$

$$= \left\{ 4 \| \frac{3}{2} \right\} + 3$$

$$= \frac{4 \times 3/2}{4 + 3/2} + 3$$

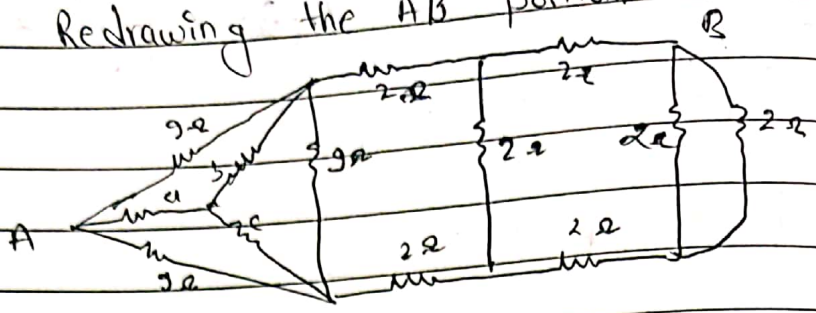
$$= 4.09\ \Omega.$$

8) Determine the equivalent resistance betⁿ the terminal a & b & the current supplied by the battary for the network shown in fig. 8.



=> Soln.

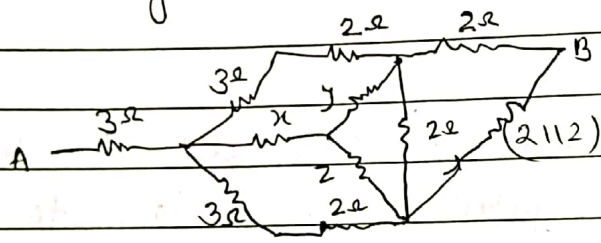
Redrawing the AB portion.



Using star-delta.

$$a = b = c = \frac{9 \times 9}{9+9+9} = 3\,\Omega$$

Redrawing Ckt of AB

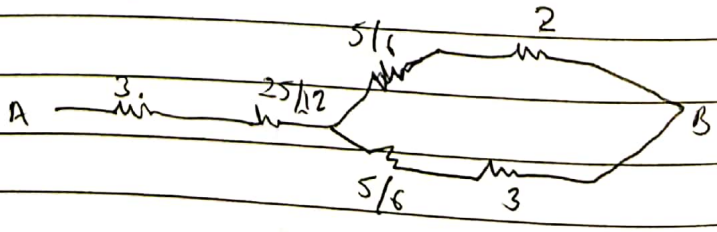


Using star-delta.

$$x = \frac{5 \times 5}{5+5+2} = \frac{25}{12}\,\Omega$$

$$y = z = \frac{2 \times 5}{5+5+2} = \frac{5}{6}\,\Omega$$

Redrawing Ckt of AB.



$$R_{eq} = 3 + \frac{25}{12} + \left[\left(\frac{5}{6}+2\right) \| \left(\frac{5}{6}+3\right)\right]$$

$$= 3 + \frac{25}{12} + \left[\frac{17}{6} \| \frac{23}{6}\right]$$

$$= 3 + \frac{25}{12} + \frac{391}{240}$$

$$= \frac{537}{80}$$

$$= 6.7125\ \Omega.$$

For ammeter (A) $= 2\ \Omega + 6.7125\ \Omega$

$$= 8.7125\ \Omega$$

Current (I) $= \frac{V}{R_T} = \frac{10}{8.7125}$

$$= 1.1477\ A$$