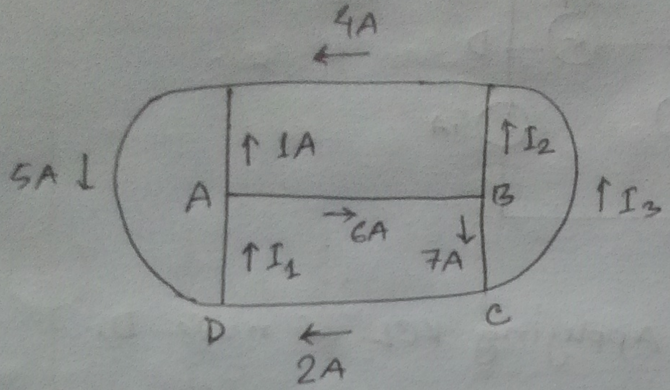
EEE-1105

2.9



Applying KCL at node D,

$I_1 = 5+2 = 7A$

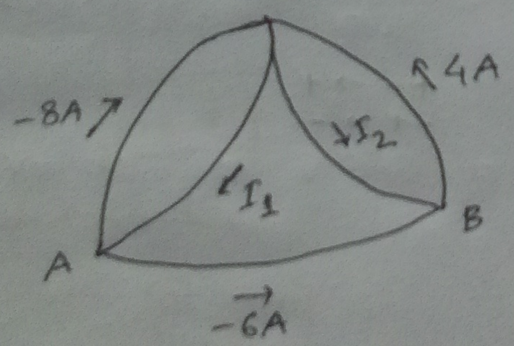
Applying KCL at node B,

$I_2 + 7 = 6$; $\therefore I_2 = -1A$

Applying KCL at node C,

$I_3 + 2A = 7$; $\therefore I_3 = 5A$

2.10



Applying KCL at node A,

$I_1 = -8-6 = -14A$

Applying KCL at node B,

$I_2 - 6 = 4 = 6+4 = 10A$

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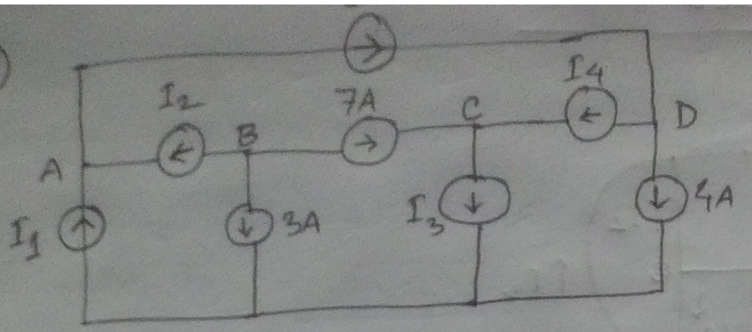
2.13



Applying KCL at node B,

$I_2 + 3 + 7 = 0$

$\therefore I_2 = -10A$

Applying KCL at node A,

$I_1 + I_2 = 2$

$\Rightarrow I_1 = 2 - I_2 \quad = 2 + 10$

$\therefore I_1 = 12A$

Applying KCL at node D,

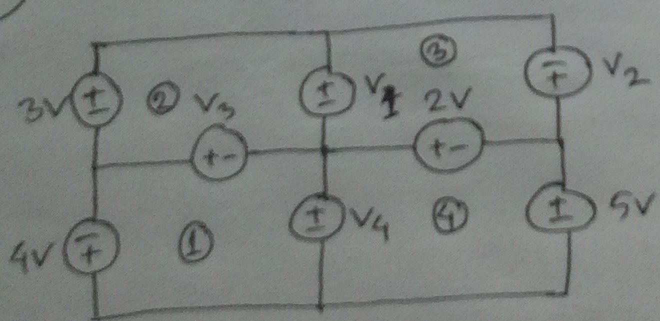
$I_4 + 4 = 2 \quad ; \therefore I_4 = -2A$

Applying KCL at node C,

$I_3 = I_4 + 7 \quad = -2 + 7$

$\therefore I_3 = \cancel{9A}\ 5A$

2.14



$+ - \rightarrow +$
$- + \rightarrow -$

Applying KVL at loop 4,

$-V_4 + 2 + 5 = 0$

$\therefore V_4 = 7V$

Applying KVL at loop 1,

$4 + V_3 + V_4 = 0$

$\Rightarrow V_3 = -4 - V_4 \quad = -4 - 7$

$\therefore V_3 = -11V$

Applying KVL at loop 2,

$-3 + V_1 - V_3 = 0 \quad \Rightarrow V_1 = V_3 + 3$

$\therefore V_1 = -8V$

Applying KVL at loop 3,

$-V_1 - V_2 - 2 = 0 \quad \Rightarrow V_2 = -V_1 - 2$

$\therefore V_2 = 6V$

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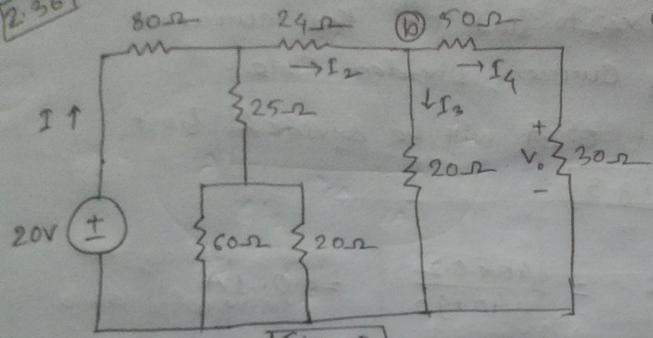
2.36



Find I and V_0

Fig-0

For obtaining I, we've to find out Req first

30Ω and 50Ω are in series.

80Ω ∥ 20Ω

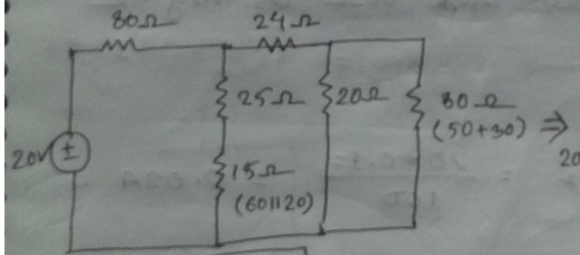


Fig 1

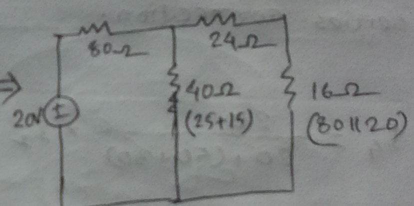


Fig 2

16Ω + 24Ω

40Ω ∥ 40Ω

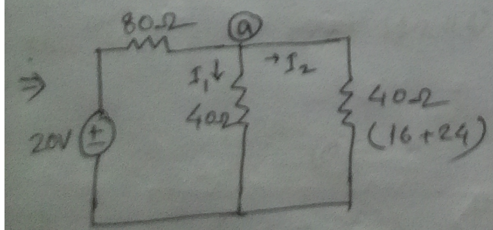


Fig 3

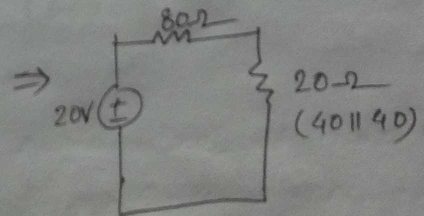


Fig 4

$\therefore R_{eq} = 80 + 20 = 100\Omega$

$\therefore I = \frac{20}{100} = 0.2A$

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For obtaining V_o, we've to find out the current through 30Ω using Current Divider Rule.

The source current 0.2A will be divided first at node ⓐ in $\boxed{\text{Fig 3}}$

$$\therefore I_2 = \frac{40}{40+40} \times I = \frac{40 \times 0.2}{40+40} = 0.1A$$

Current I_2 will be divided into I_3 and I_4 ~~sh~~ at node ⓑ shown in $\boxed{\text{Fig 0}}$. The same current I_4 will be flowed through 50Ω and 30Ω as they're in series connection.

$$\therefore I_4 = \frac{20}{20+(50+30)} \times I_2 = \frac{20 \times 0.1}{100} = 0.02A$$

$$\therefore V_o = 30 \times 0.02 = 0.6V = 600 mV$$

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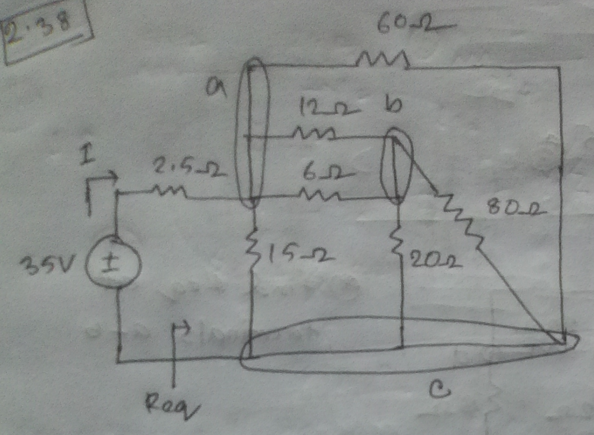
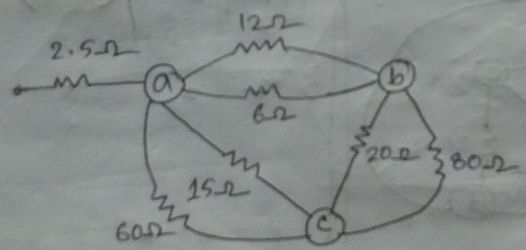
2.38

* Find Req and I

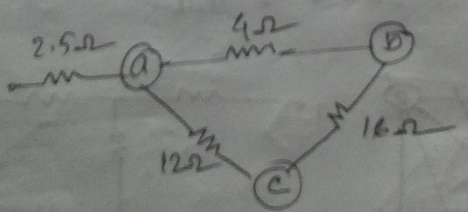


The circuit is simplified and redrawn



Now, it is clear that (12 ‖ 6), (80 ‖ 20) and (60 ‖ 15)

⇒



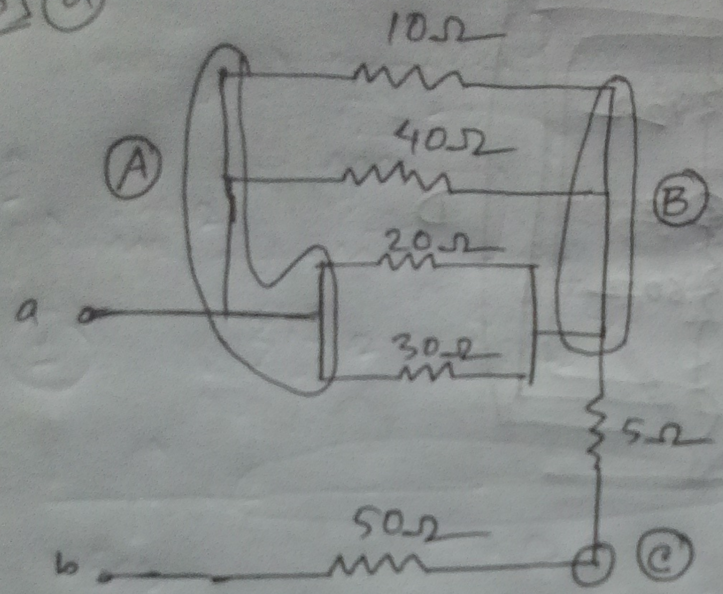
4 and 16 are in series with parallel to 12.

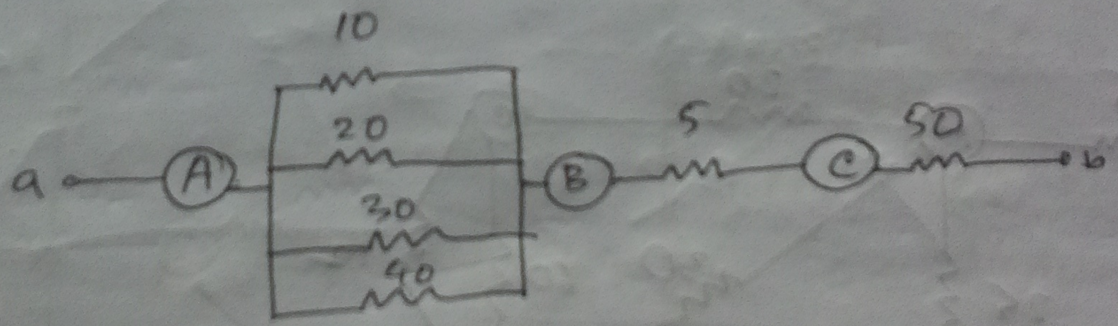
$\therefore R_{eq} = \{(4+16) \parallel 12\} + 2.5$

$$\therefore R_{eq} = 10\,\Omega$$

$$I_0 = \frac{35}{10} = 3.5\,A$$

2.45 (a)

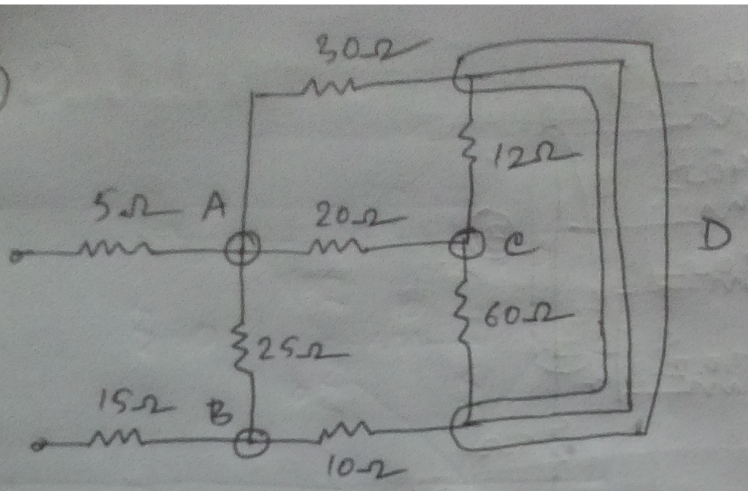




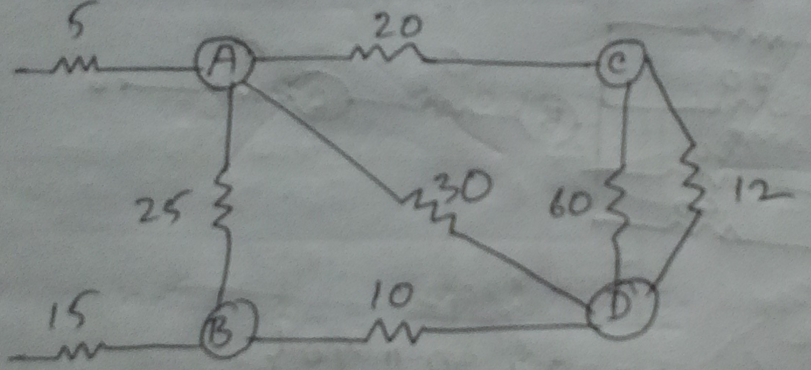
$\therefore R_{eq} = 5 + 50 + \{10 \parallel 20 \parallel 30 \parallel 40\}$

$= 59.8\ \Omega$

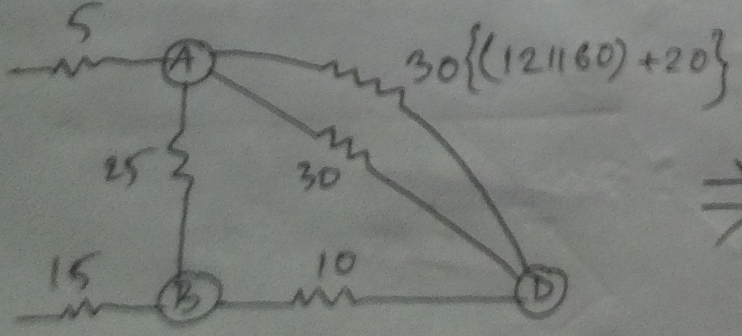
2.6.5 (b)



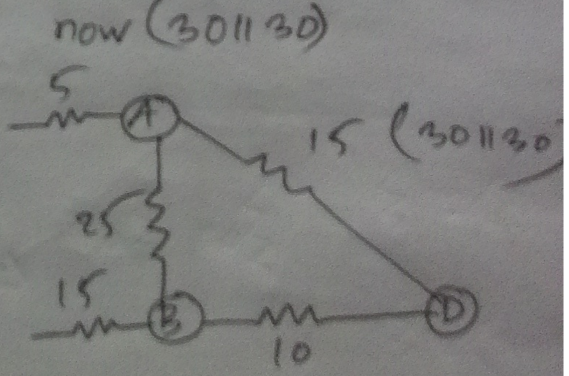
⇓



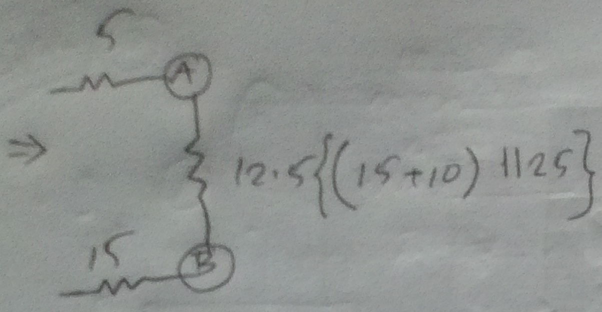
12 and 60 in parallel those ~~will~~ are in ~~[illegible]~~ series with 20.



⇒



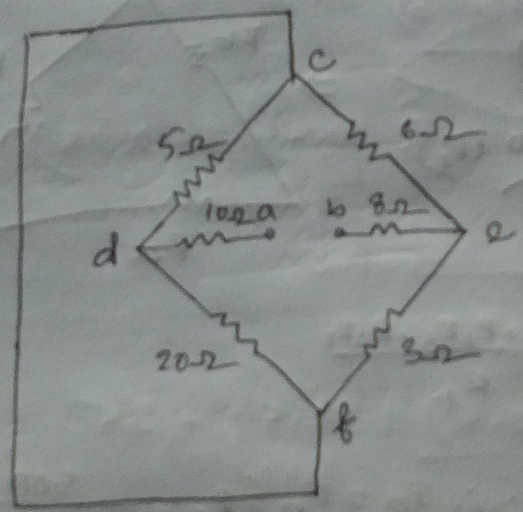
Now, (15 and 10 in series) → Parallel with 25



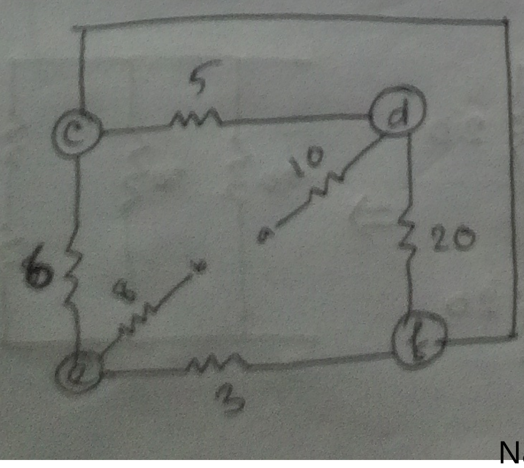
$\therefore R_{eq} = 5 + 12.5 + 15$

$= 32.5\ \Omega$

$\boxed{2.47}$



$\Downarrow$



5 and 20 are in parallel that is series with 10

$\therefore R_{eq}' = (5 \| 20) + 10$

$= 14\ \Omega$

6 and 3 are in parallel that is series with 8

$\therefore R_{eq}'' = (6 \| 3) + 8$

$= 10\ \Omega$

R_{eq}' and R_{eq}'' are in series.

$\therefore R_{eq} = 14 + 10$

$= 24\ \Omega$

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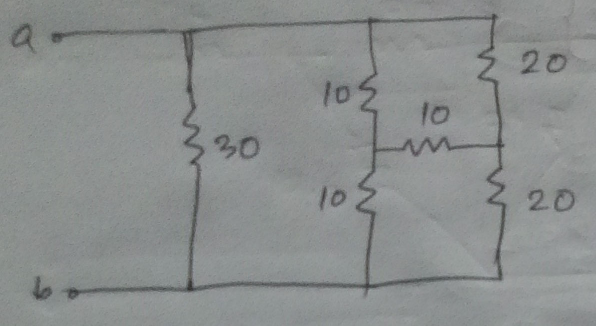
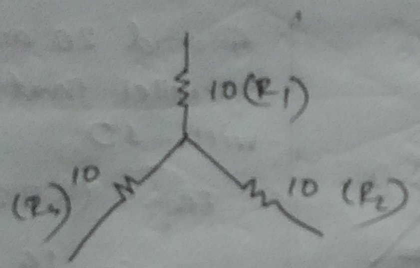
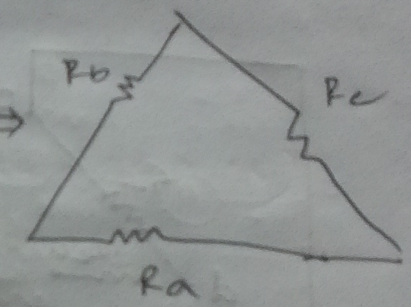
2.51 (a)



Applying Y→Δ approach in this section



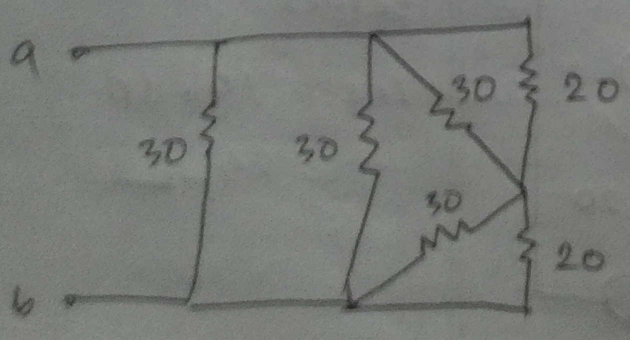
⇒



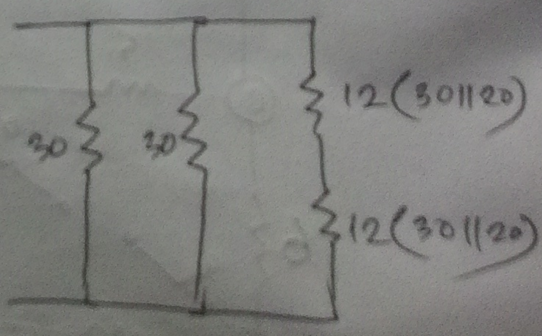
We know that, $R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$

Here, $R_1 = R_2 = R_3 = 10\,\Omega$; $\therefore R_a = R_b = R_c = \frac{300}{10} = 30\,\Omega$

⇓



⇒



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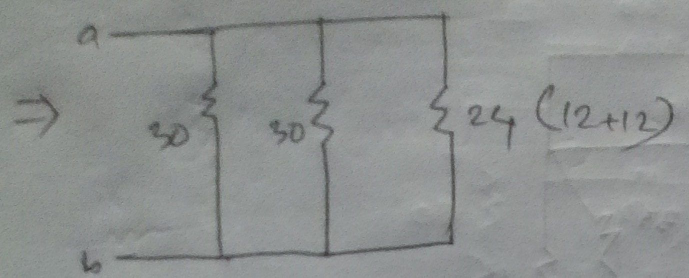
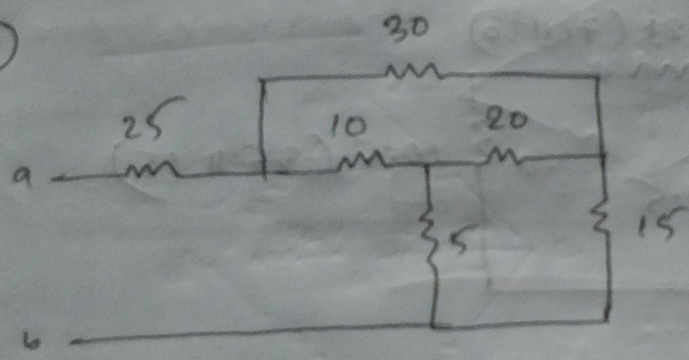


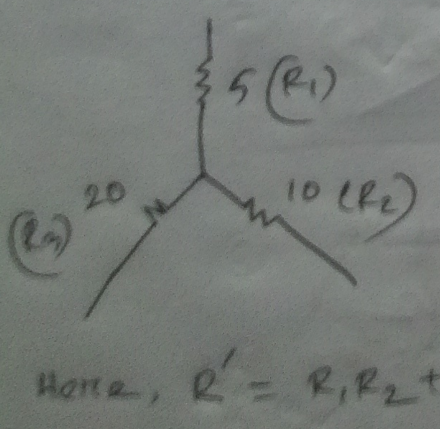
$\therefore R_{eq} = 30 \parallel 30 \parallel 24$

$= 9.231\ \Omega$.

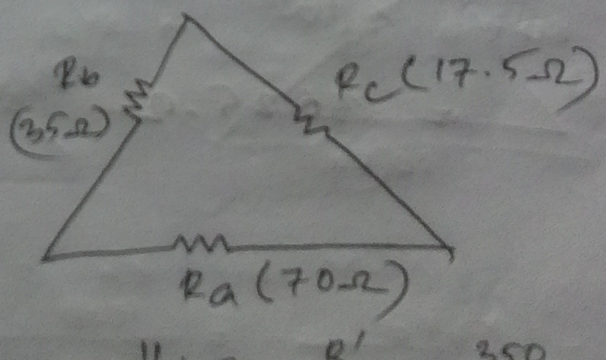
$\boxed{2.51}$ (b)



$Y \rightarrow \Delta$ Approach



$\Rightarrow$



Here, $R' = R_1R_2 + R_2R_3 + R_3R_1$

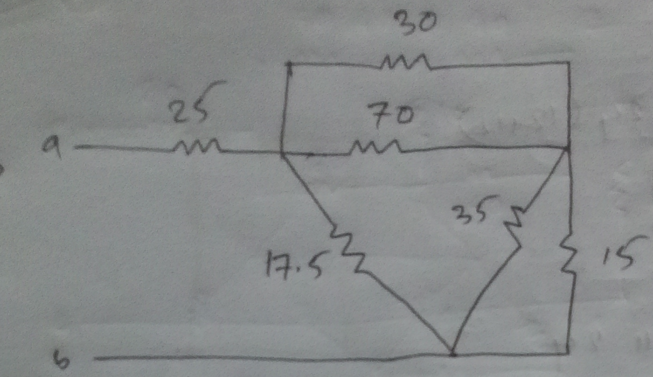
$= 350$

$\therefore R_a = \frac{R'}{R_1} = \frac{350}{5} = 70\Omega$

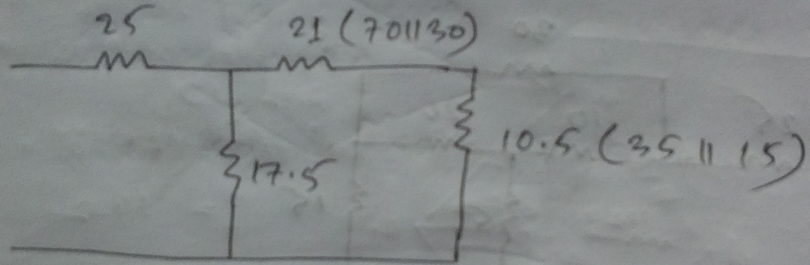
$R_b = \frac{R'}{R_2} = \frac{350}{10} = 35\Omega$

$R_c = \frac{R'}{R_3} = \frac{350}{20} = 17.5\Omega$

$\Rightarrow$



$(70 \parallel 30)$ and $(35 \parallel 15)$



$$\therefore R_{eq} = \{(21 + 10.5) \parallel 17.5\} + 25$$

$$= 36.25\ \Omega$$

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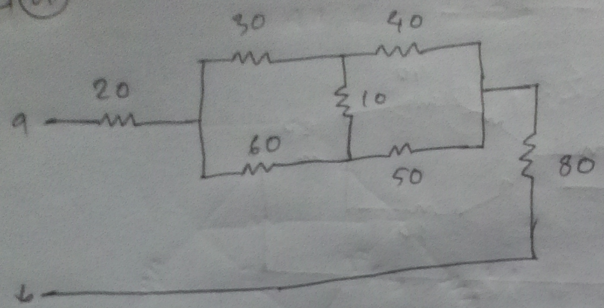
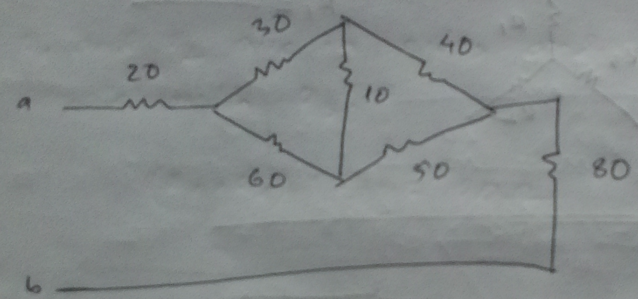
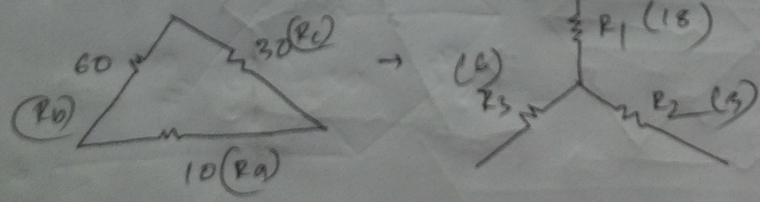
2.53 (a)



this circuit is looks like this



Applying Δ-Y approach,

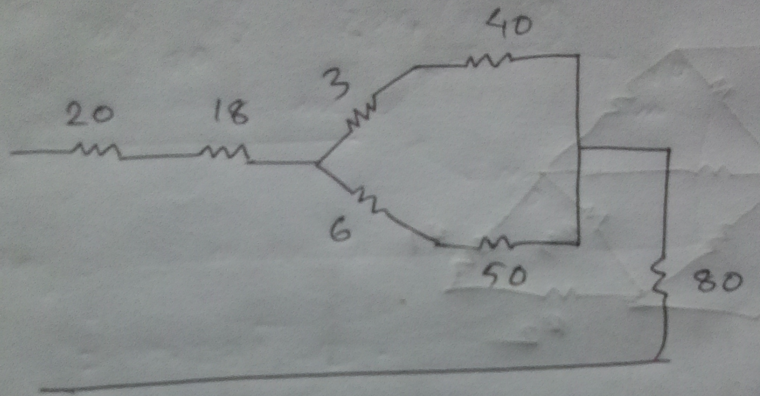


$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{1800}{100} = 18\,\Omega$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c} = \frac{300}{100} = 3\,\Omega$$

$$R_3 = \frac{R_a R_b}{R_a+R_b+R_c} = \frac{600}{100} = 6\,\Omega$$

$\Rightarrow$



$$R_{eq}' = (3+40) \parallel (6+50)$$

$$= \frac{2408}{99}\,\Omega$$

$$\therefore R_{eq} = 20+18+\frac{2408}{99}+80$$

$$= 142.323\,\Omega.$$

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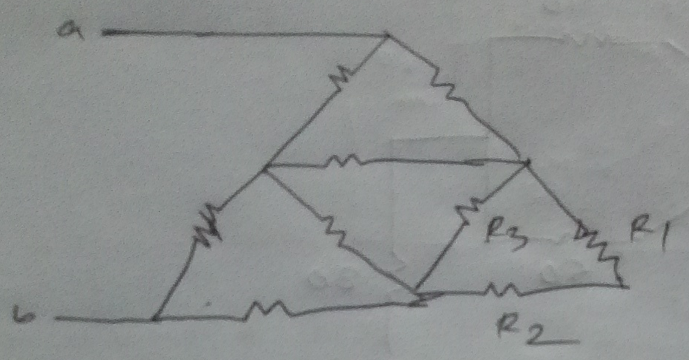
2.53 (b)

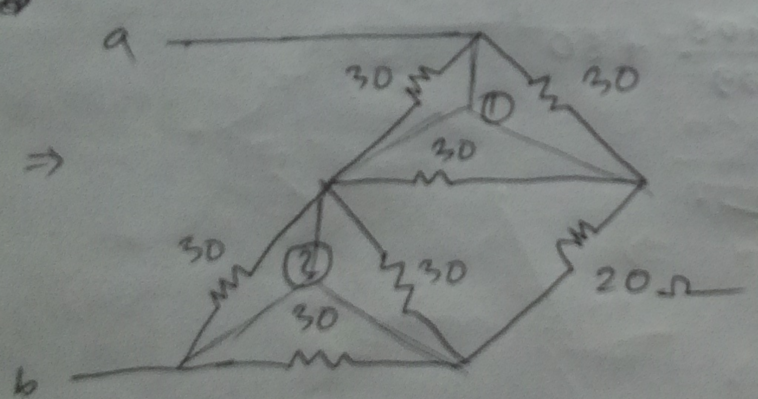
All $R = 30\Omega$



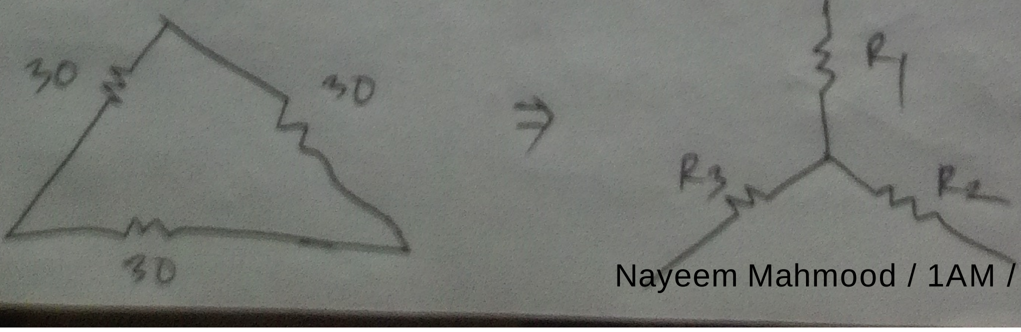
R_1 and R_2 are in series and (R_1+R_2) are in parallel with R_3.

$$(R_1+R_2) \parallel R_3 = 20\Omega$$

$\Rightarrow$



Applying $\Delta \to Y$ approach in section 1 and 2



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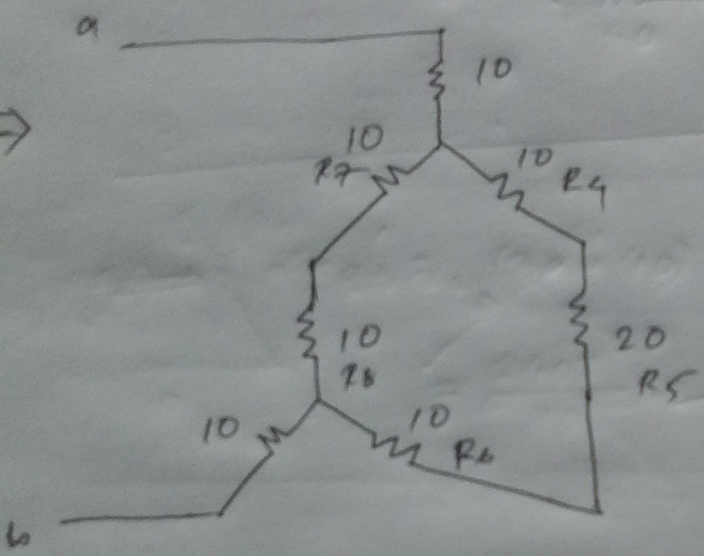
Here $R_a = R_b = R_c = 30\Omega$

$$\therefore R_1 = R_2 = R_3 = \frac{30 \times 30}{30+30+30} = 10\Omega$$

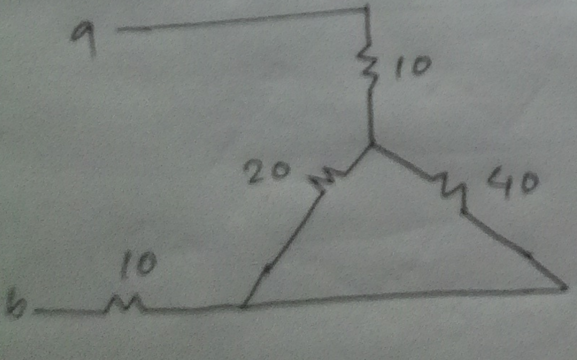
$\Rightarrow$



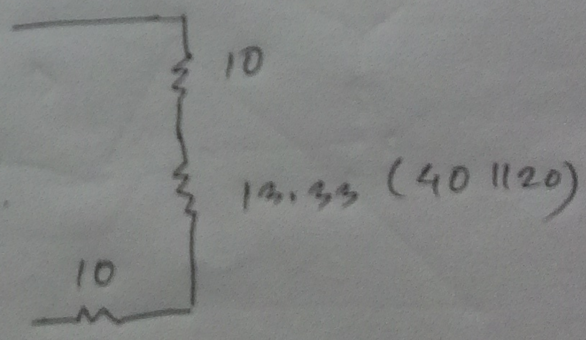
R_4, R_5, R_6 in series
R_7, R_8 in series

They are in parallel

$\Downarrow$



$\Rightarrow$



$$\therefore R_{eq} = 10 + 13.33 + 10$$
$$= 33.33\ \Omega.$$

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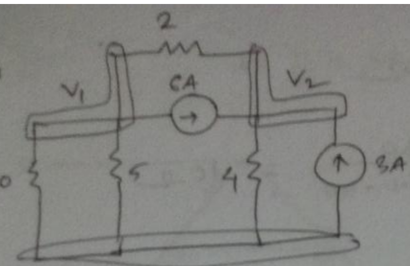
3.2



$V_{ref} = 0V$

at node 1,

$$V_1\left(\frac{1}{2}+\frac{1}{5}+\frac{1}{10}\right) - V_2\left(\frac{1}{2}\right) = -6$$

$$\Rightarrow \frac{4V_1}{5} - \frac{V_2}{2} = -6$$

$$\Rightarrow \frac{8V_1 - 5V_2}{10} = -6$$

$$\therefore 8V_1 - 5V_2 = -60 \quad \text{---} \quad (1)$$

at node 2,

$$V_2\left(\frac{1}{2}+\frac{1}{4}\right) - V_1\left(\frac{1}{2}\right) = 6+3$$

$$\Rightarrow \frac{3V_2}{4} - \frac{V_1}{2} = 9$$

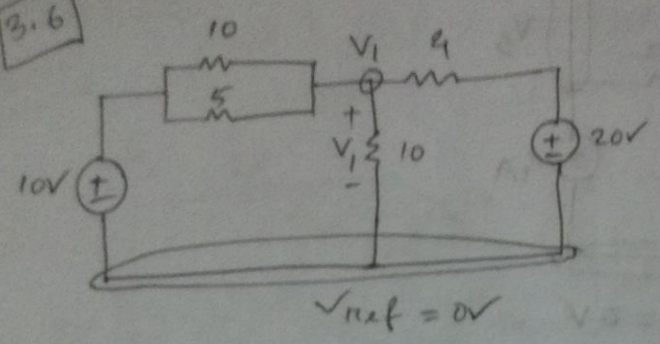
$$\Rightarrow \frac{3V_2 - 2V_1}{4} = 9$$

$$\therefore -2V_1 + 3V_2 = 36 \quad \text{---} \quad (2)$$

$\therefore V_1 = 0V$

$V_2 = 12V$

3.6



* Without Source Transformation

There are four resistors - 4, 5, 10, 10. All are connected to node V_1. But on the left side, 10 and 5 are connected to 10V and on the right side 4 is connected to 20V.

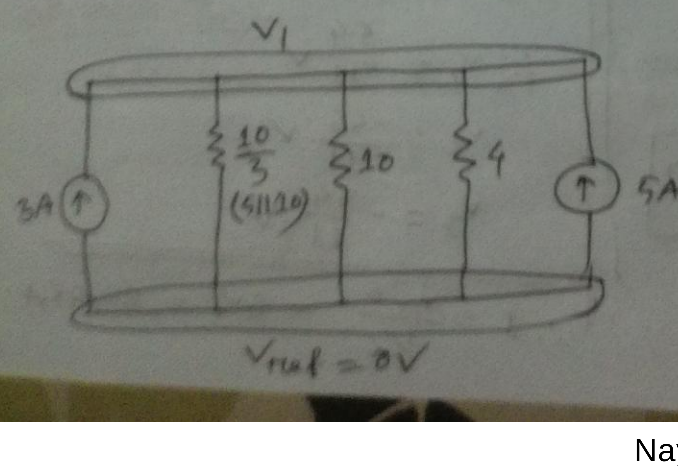
Using noda analysis,

$$V_1\left(\frac{1}{4}+\frac{1}{5}+\frac{1}{10}+\frac{1}{10}\right) - 10\left(\frac{1}{5}+\frac{1}{10}\right) - 20\left(\frac{1}{4}\right) = 0$$

$$\Rightarrow \frac{13V_1}{20} - 3 - 5 = 0$$

$$\boxed{\therefore V_1 = 12.308\ V}$$

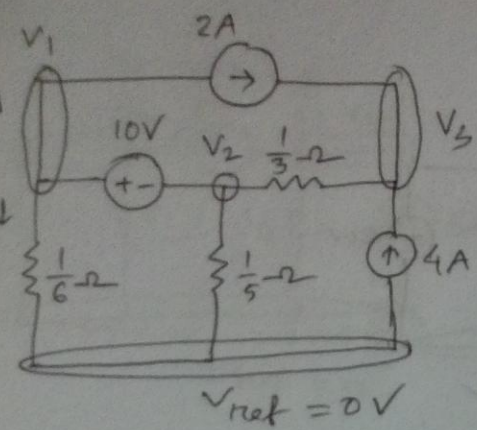
* Using Source Transformation



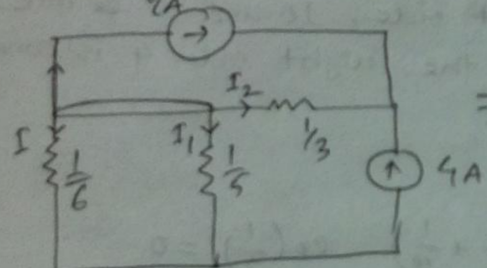
$$\Rightarrow V_1\left(\frac{1}{4}+\frac{1}{10}+\frac{3}{10}\right) = 5+3$$

$$\boxed{\therefore V_1 = 12.308\ V}$$

$\boxed{3.15}$



V_1 and V_2 form a supernode.



Applying KCL at supernode,

$\Rightarrow I + I_1 + I_2 + 2 = 0$

$\Rightarrow \frac{V_1 - 0}{1/6} + \frac{V_2 - 0}{1/5} + \frac{V_2 - V_3}{1/3} + 2 = 0$

$\Rightarrow 6V_1 + 5V_2 + 3V_2 - 3V_3 = -2$

$\boxed{\therefore 6V_1 + 8V_2 - 3V_3 = -2 \; \ldots \; (1)}$

Applying KCL at node 3,

$I_2 + 4 + 2 = 0$

$\Rightarrow \frac{V_2 - V_3}{1/3} = -6$

$\boxed{\Rightarrow 3V_2 - 3V_3 = -6 \; \ldots \; (2)}$

From supernode,

$V_1 - V_2 = 10$ —— (3)

$\therefore V_1 = \frac{54}{11} V$

$V_2 = \frac{-56}{11} V$

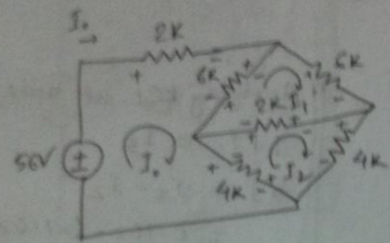
$V_3 = -\frac{34}{11} V$

$\therefore I = \frac{V_1 - 0}{1/6} = 6V_1 = 29.45A$

[illegible]

3.40

* Find I_o using mesh analysis.



Applying KVL

at mesh-0,

$$-56 + 2000 I_o + 6000(I_o - I_1) + 4000(I_o - I_2) = 0$$

$$\Rightarrow 6000 I_o + 4000 I_o + 2000 I_o - 6000 I_1 - 4000 I_2 = 56$$

$$\therefore 12000 I_o - 6000 I_1 - 4000 I_2 = 56 \quad \text{——} (1)$$

at mesh-1,

$$2000(I_1 - I_2) + 6000(I_1 - I_o) + 6000 I_1 = 0$$

$$\therefore -6000 I_o + 14000 I_1 - 2000 I_2 = 0 \quad \text{——} (2)$$

at mesh-2,

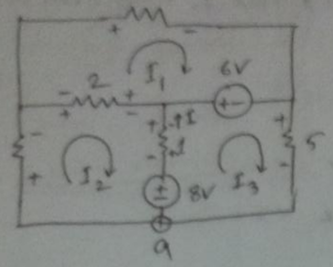
$$2000(I_2 - I_1) + 4000 I_2 + 4000(I_2 - I_o) = 0$$

$$\therefore -4000 I_o - 2000 I_1 + 10000 I_2 = 0 \quad \text{——} (3)$$

$\therefore I_o = 8mA$

$I_1 = 4mA$ $\qquad I_2 = 4mA$

$\boxed{3.41}$



* Find I using mesh analysis

Applying KVL

at mesh 1,

$$-6+2(I_1-I_2)+10I_1=0$$

$$\therefore 12I_1-2I_2=6 \quad —— (1)$$

at mesh 2,

$$8+4I_2+2(I_2-I_1)+1(I_2-I_3)=0$$

$$\therefore -2I_1+7I_2-I_3=-8 \quad —— (2)$$

at mesh 3,

$$-8+1(I_3-I_2)+6+5I_3=0$$

$$\Rightarrow -I_2+6I_3=2 \quad —— (3)$$

$\therefore I_1=0.329A$

$I_2=-1.026A$

$I_3=0.162A$

Applying KCL at node (a)

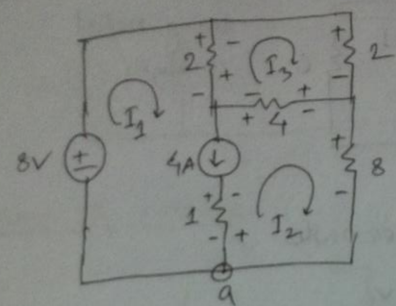
$$I+I_2=I_3$$

$$\Rightarrow I=I_3-I_2$$

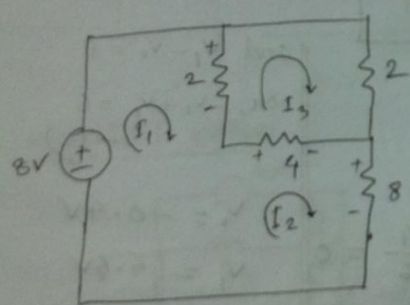
$$=0.162-(-1.026)$$

$$=1.188\ A$$

Practice 3.7



Using supermesh approach,



$\Rightarrow$ Applying KVL at supermesh.

$$-8+2(I_1-I_3)+4(I_2-I_3)+8I_2=0$$

$$\Rightarrow 2I_1+12I_2-6I_3=8 \quad \text{---} (1)$$

Applying KCL at node (a)

$$I_2+4=I_1$$

$$\therefore I_1-I_2=4 \quad \text{---} (3)$$

At mesh 3

$$2(I_3-I_1)+2I_3+4(I_3-I_2)=0$$

$$\Rightarrow -2I_1-4I_2+8I_3=0$$

$$\therefore I_1+2I_2-4I_3=0 \quad \text{---} (2)$$

$$\therefore I_1 = 4.632\text{ A}$$

$$I_2 = 0.632\text{A}$$

$$I_3 = 1.474\text{ A}$$

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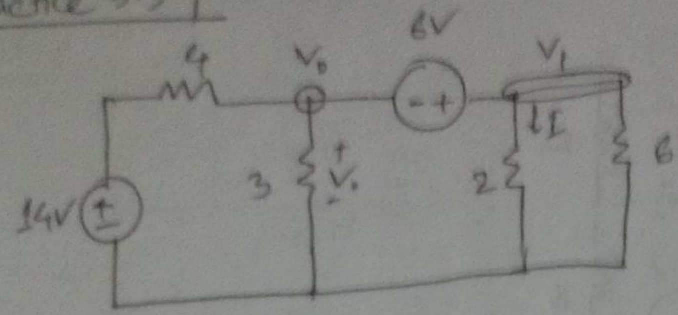
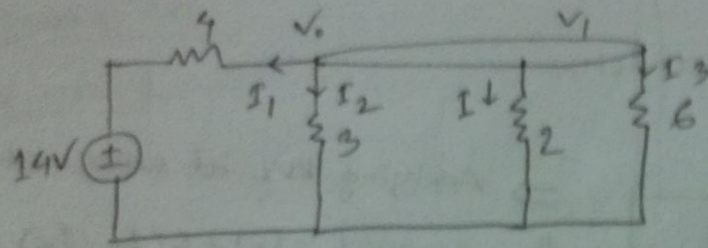
Practice 3.3



* Find V_0 and I using nodal analysis.

V_0 and V_1 nodes form a supernode



Applying KCL at supernode,

$$I_1 + I_2 + I + I_3 = 0$$

$$\Rightarrow \frac{V_0 - 14 - 0}{4} + \frac{V_0}{3} + \frac{V_1}{2} + \frac{V_1}{6} = 0$$

$$\Rightarrow \frac{3V_0 - 42 + 4V_0 + 6V_1 + 2V_1}{12} = 0$$

$$\therefore 7V_0 + 8V_1 = 42 \quad \text{——(1)}$$

and $V_1 - V_0 = 6$

or, $-V_0 + V_1 = 6$ ——(2)

$\therefore V_0 = -0.4V$

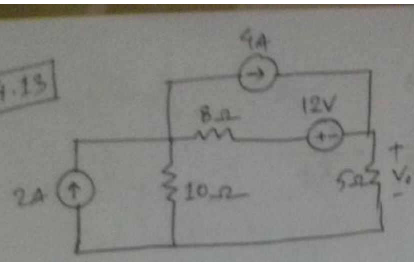
$V_1 = 5.6V$

and $I = \frac{V_1}{2}$

$= \frac{5.6}{2}$

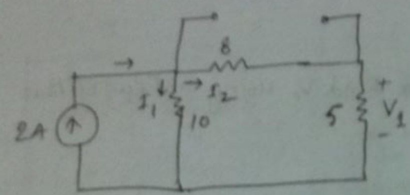
$= 2.8A.$

$\boxed{4.13}$



* Using superposition, find V_o

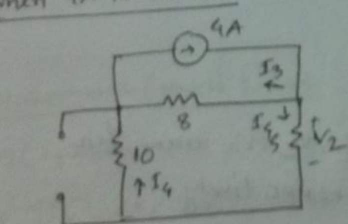
When 2A is active



$\Rightarrow \therefore I_2 = \frac{10 \times 2}{10+8+5} = \frac{20}{23}$ A

$\therefore V_1 = 5 \times I_2 = \frac{100}{23}$ V

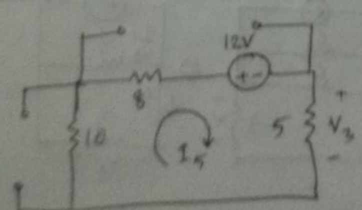
When 4A is active



$\Rightarrow \therefore I_4 = \frac{8 \times 4}{10+8+5} = \frac{32}{23}$ A

$\therefore V_2 = 5 \times I_4 = \frac{160}{23}$ V

When 12V is active



$\Rightarrow$ Applying KVL,

$10I_5 + 8I_5 + 12 + 5I_5 = 0$

$\Rightarrow I_5 = -12/23$ A

$\therefore V_3 = 5I_5$

$= 5 \times \frac{-12}{23} = -\frac{60}{23}$ V

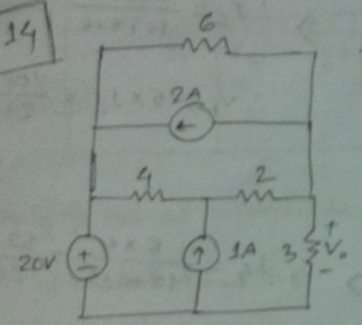
$\therefore$ Total $V_0 = V_1 + V_2 + V_3$

$$= \frac{100}{23} + \frac{160}{23} - \frac{60}{23}$$

$$= \frac{200}{23} \checkmark$$

$$= 8.696 \text{ V}.$$

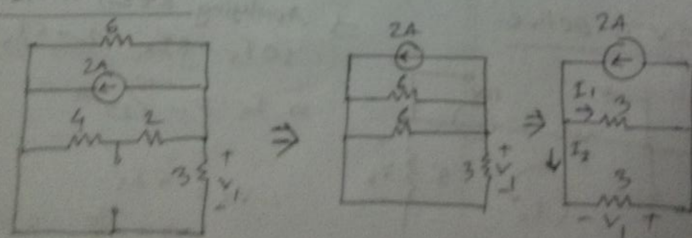
$\boxed{4.14}$



* Find V_0 using superposition

Let, $V_0 = V_1 + V_2 + V_3$ where V_1, V_2, V_3 are for 2A, 1A and 20V sources respectively.

When 2A is active

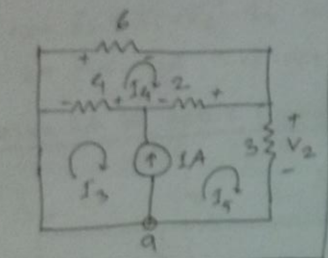


$\therefore I_2 = -\frac{3\times 2}{3+3} = -1A$

$\therefore V_1 = 3\times I_2$

$= -3V$

When 1A is active



We'll use mesh/supermesh analysis to obtain V_2

At mesh 4

$2(I_4-I_5)+4(I_4-I_3)+6I_4=0$

$\therefore -4I_3+12I_4-2I_5=0$ — (1)

At supermesh (mesh 3 & 5)

$4(I_3-I_4)+2(I_5-I_4)+3I_5=0$

$\Rightarrow 4I_3-6I_4+5I_5=0$ — (2)

applying KCL at node a,

$I_5 = 1 + I_3$

$\therefore -I_3+I_5=1$ — (3)

$\therefore I_3 = -2/3 A$

$I_4 = -1/6 A$

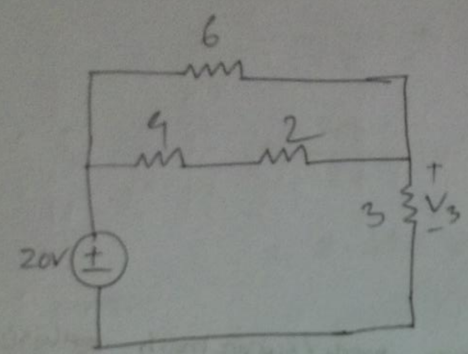
$I_5 = 1/3 A$

$\therefore V_2 = 3I_5$

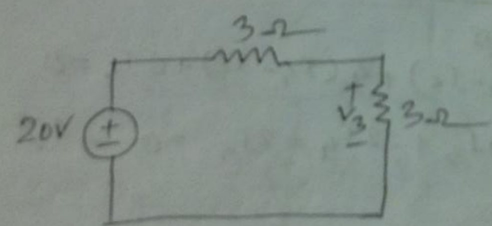
$= 3\times\frac{1}{3}$

$= 1V$

When 20V is active



$$(4+2) \parallel 6 = 3\Omega$$



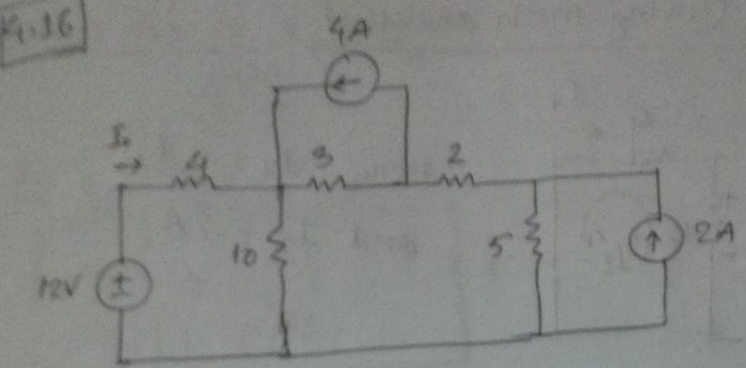
Using VDR, $V_3 = \frac{3 \times 20}{3+3} = 10V$

$\therefore$ Total $V_o = V_1 + V_2 + V_3$

$= -3 + 1 + 10$

$= 8V$

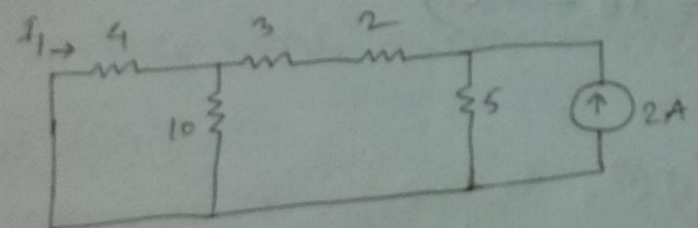
4.16



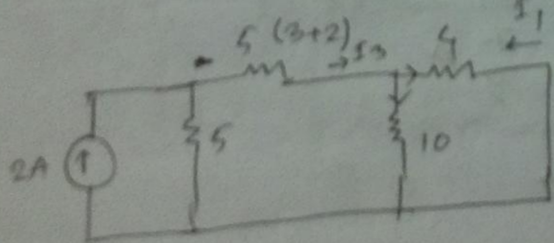
* Find I_0 using superposition analysis.

Let $I_0 = I_1 + I_2 + I_3$ where I_1, I_2 and I_3 are for 2A, 4A and 12V sources respectively.

when 2A is active (using CDR)



⇓



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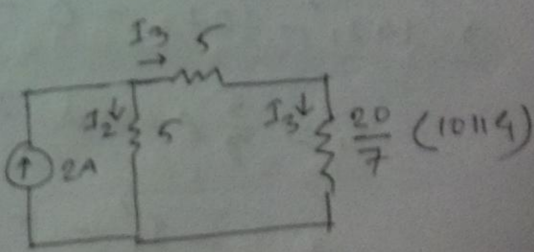
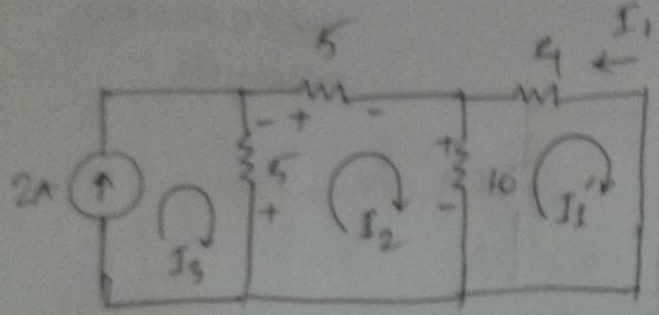


$$\therefore I_3 = \frac{5\times 2}{5+5+\frac{20}{7}} = \frac{7}{9}\ A$$

$$\therefore I_1 = \frac{-10\times\frac{7}{9}}{4+10} = -\frac{5}{9}\ A$$

When 2A is active (using mesh analysis)



Here, $I_1 = -I_1'$
and $I_3 = 2A$

at mesh 2

$$5(I_2 - I_3) + 5(I_2) + 10(I_2 - I_1') = 0$$

$$\Rightarrow -10I_1' + 20I_2 = 5I_3$$

$$\therefore -10I_1' + 20I_2 = 10 \text{ --- (1)}$$

at mesh 1

$$10(I_1' - I_2) + 4I_1' = 0$$

$$\Rightarrow 14I_1' - 10I_2 = 0 \text{ --- (2)}$$

$$\therefore I_1' = \frac{5}{9}A \text{ and } I_2 = \frac{7}{9}A$$

$$\therefore I_1 = -I_1' = -5/9 \, A$$

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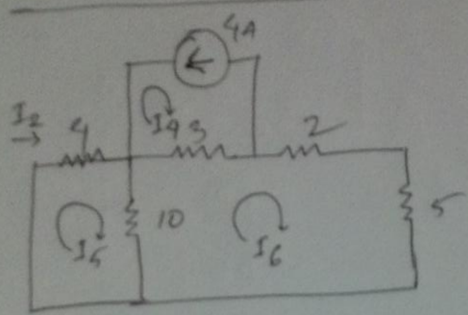
When 4A is active



Here $I_4 = -4A$

and $I_5 = I_2$

at mesh 6

$$10(I_6 - I_5) + 3(I_6 - I_4) + 2I_6 + 5I_6 = 0$$

$$\Rightarrow -10I_5 + 20I_6 = 3I_4$$

$$\therefore -10I_5 + 20I_6 = -12 \quad \text{—— (1)}$$

at mesh 5

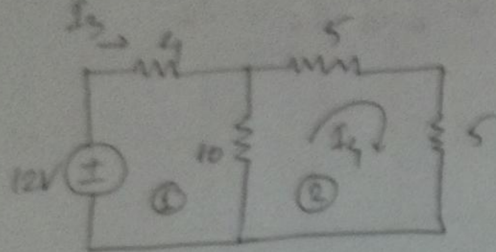
$$4I_5 + 10(I_5 - I_6) = 0$$

$$\Rightarrow 14I_5 - 10I_6 = 0 \quad \text{—— (2)}$$

$$\therefore I_5 = \frac{-2}{3}A \quad \text{and} \quad I_6 = \frac{-14}{15}A$$

$$\therefore I_2 = \frac{-2}{3}A$$

When 12V is active



Applying KVL at mesh 1,

$$-12 + 4I_3 + 10(I_3 - I_4) = 0$$

$$\Rightarrow 14I_3 - 10I_4 = 12 \quad \text{——(1)}$$

at mesh 2,

$$5I_4 + 5I_4 + 10(I_4 - I_3) = 0$$

$$\Rightarrow -10I_3 + 20I_4 = 0 \quad \text{——(2)}$$

$$\therefore I_3 = \frac{4}{3}A \quad \text{and} \quad I_4 = \frac{2}{3}A$$

$$\therefore I_0 = I_1 + I_2 + I_3$$

$$= -\frac{5}{9} + \frac{-2}{3} + \frac{4}{3}$$

$$= \frac{1}{9}A$$

$$= 0.111\ A$$