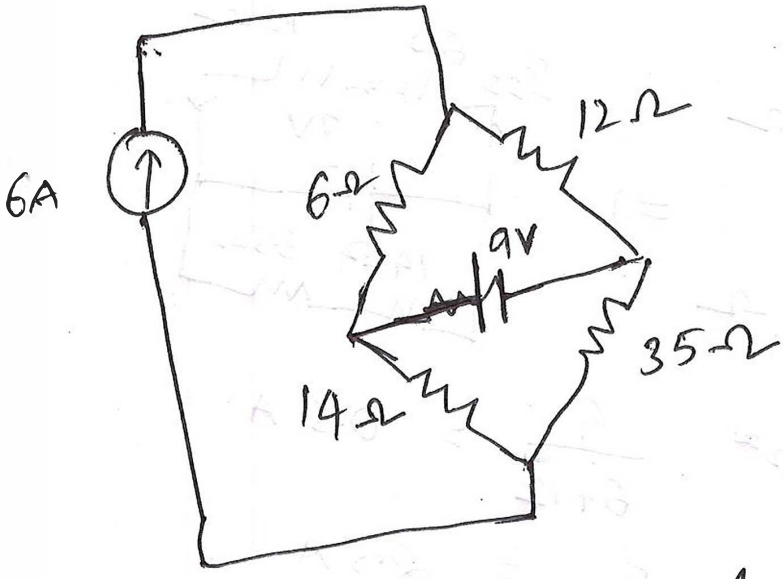
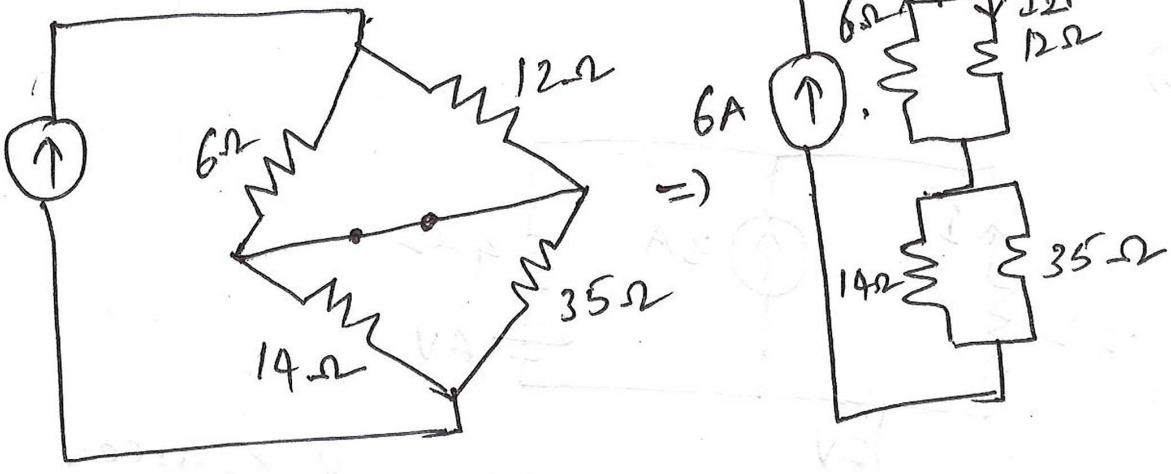
Solutions to Tutorial Sheet-7

1)



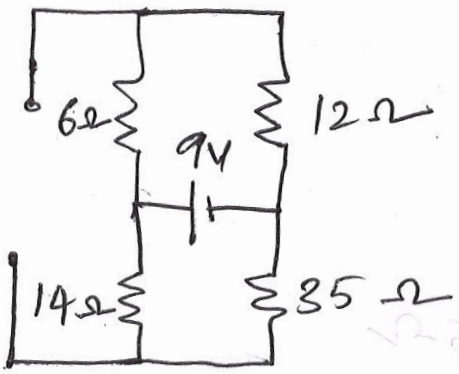
1st Consider the effect of 6A source.



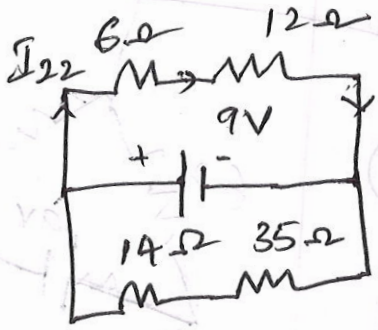
$$I_{21} = \frac{6A \times 6\Omega}{(6\Omega + 12\Omega)} = 2A$$

Consider the effect of 9V source.
Re-drawing the circuit,

P.T.O)



$\Rightarrow$

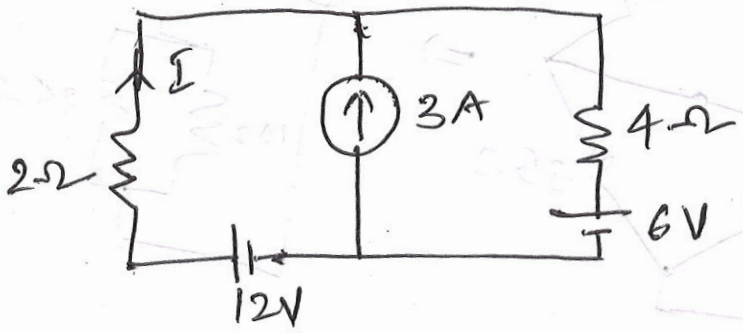


$$I_{22} = \frac{9}{6+12} = 0.5\ A$$

Thus,

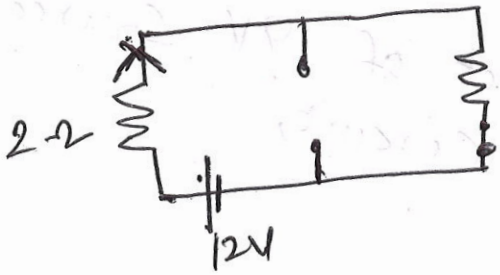
$$I_2 = I_{21} + I_{22} = \underline{\underline{2.5\ A}}$$

2)



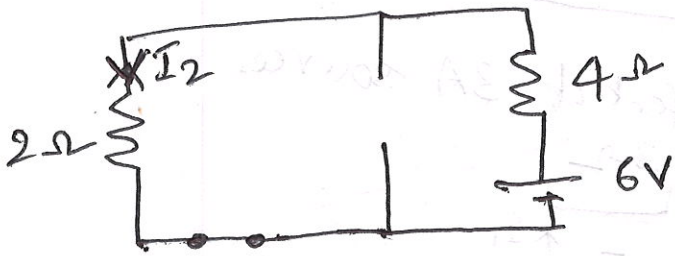
Consider the effect of 12 V source.

Re-drawing the circuit,



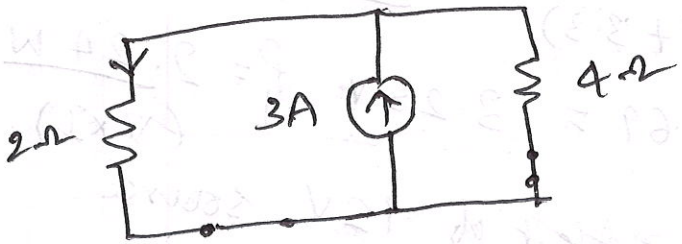
$$I_1 = \frac{12}{2+4} = 2A$$

Consider the effect of 6V source:



$$I_2 = \frac{6}{2+4} = 1A$$

Consider the effect of 3A source



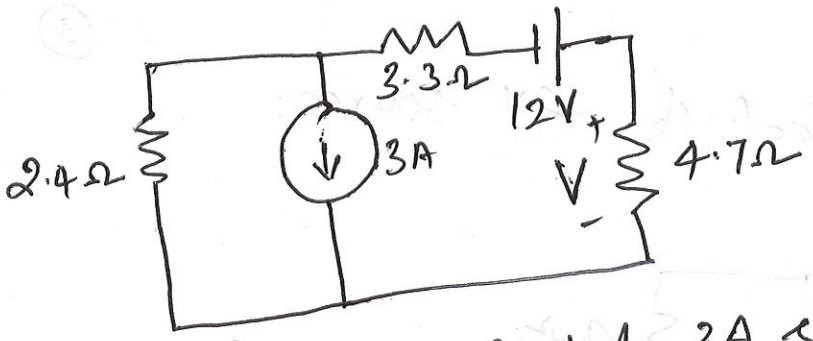
$$I_3 = \frac{3 \times 4}{2+4} = 2A$$

The total current through 2Ω resistor is

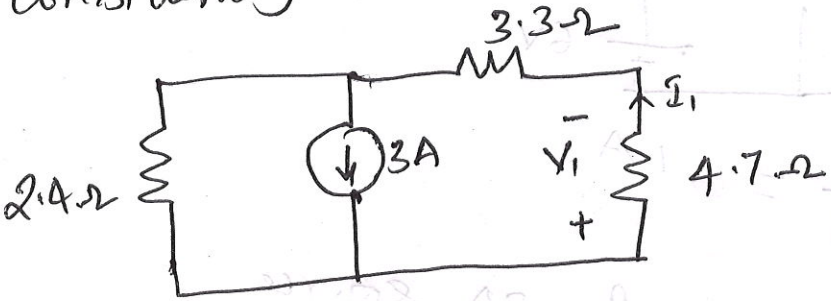
$I = I_1 + I_2 + I_3 = -2 + 1 + 2 = \underline{1A}$

(∵ I_1 is in opposite direction to I_2 and I_3)

3



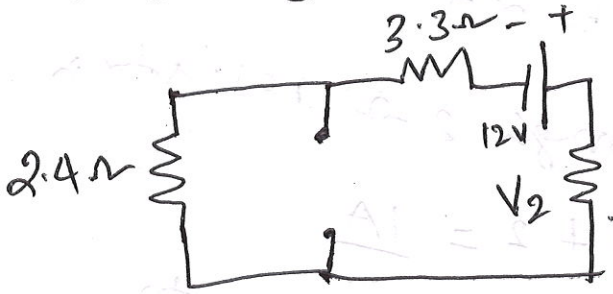
Considering the effect of 3A source.



$$I_1 = \frac{2.4 \times 3A}{2.4 + (4.7 + 3.3)} = 0.69A$$

$V_1 = 4.7 \times 0.69 = 3.25V$ $P_1 = 2.24W$ $(V \times I)$

considering the effect of 12V source



$V_2 = \frac{12 \times 4.7}{4.7 + 2.4 + 3.3}$

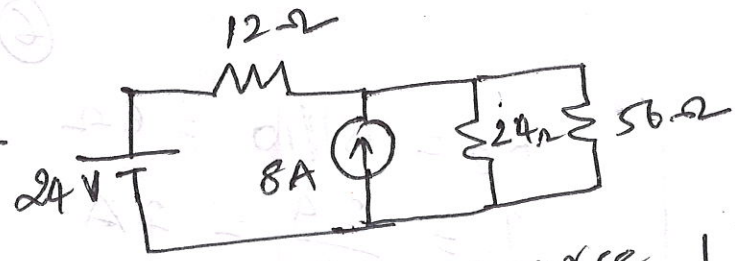
$V_2 = 5.53V$ $P_2 = 6.51W$ (V^2/R)

$V = 5.53 - 3.25 = 2.28V$

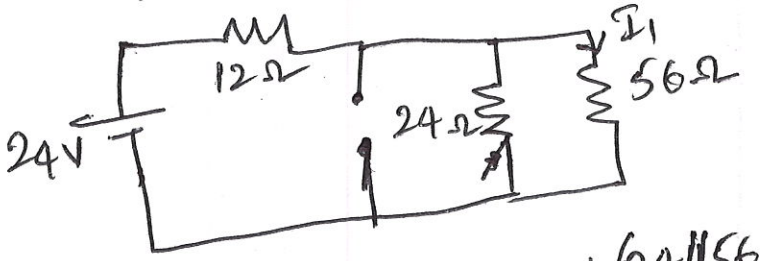
$P = \frac{V^2}{R} = \frac{(2.28)^2}{4.7} = 1.106W$

$P_1 + P_2 \neq P$

4



Considering 24V source



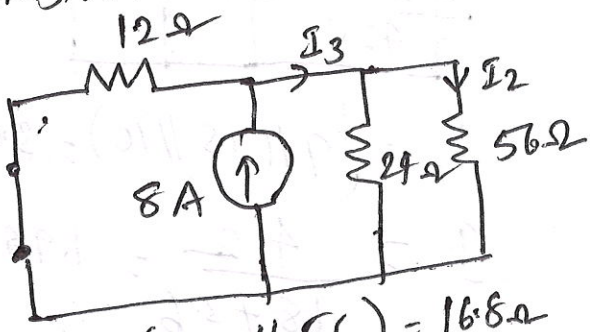
$I_1 = \frac{24V}{R}$ $R = 12 + (24 \| 56)$

$= 28.8\Omega$

$= 0.833\,A$

$I_1 = \frac{0.833 \times 24}{24+56} = 0.25A$

Considering 8A source



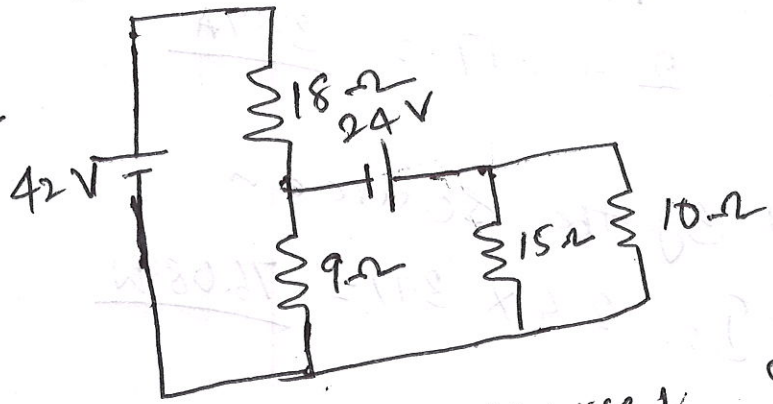
$R_T = (24 \| 56) = 16.8\Omega$

$I_3 = \frac{8 \times 12}{12+16.8} = 3.33A$

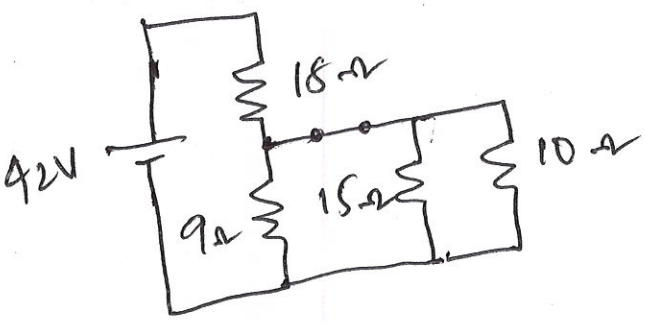
$I_2 = \frac{3.33 \times 24}{24+56} = 1A$

$I = I_1 + I_2 = 0.25 + 1 = \underline{1.25\,A}$

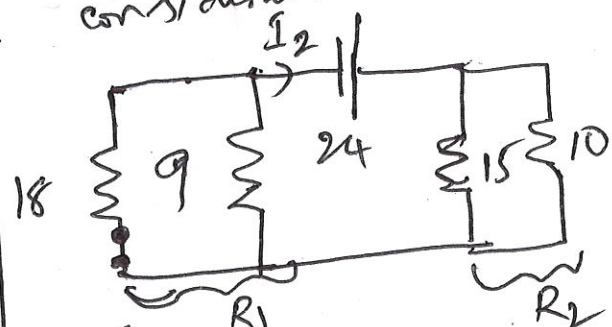
5



Considering 42V source



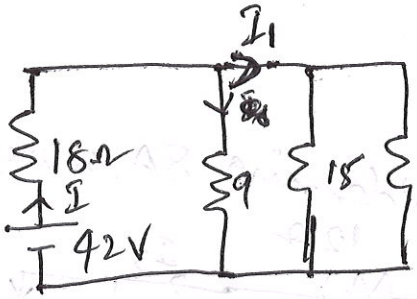
considering 24V source



$I_2 = \frac{24}{R_1 + R_2}$

$R_1 = 18 \| 9 = 6\Omega$

1



$R_1 = (9 \| 15 \| 10) = 3.6\Omega$

$I = \frac{42}{18+3.6} = 1.944A$

$I_1 = \frac{9 \times 1.944}{9\Omega + (15\|10)} = \underline{1.17A}$

(Total current flowing through 18Ω resistor gets divided in to two parts. one part through 9Ω and other through 24V source)

$R_2 = 15 \| 10 = 6\Omega$

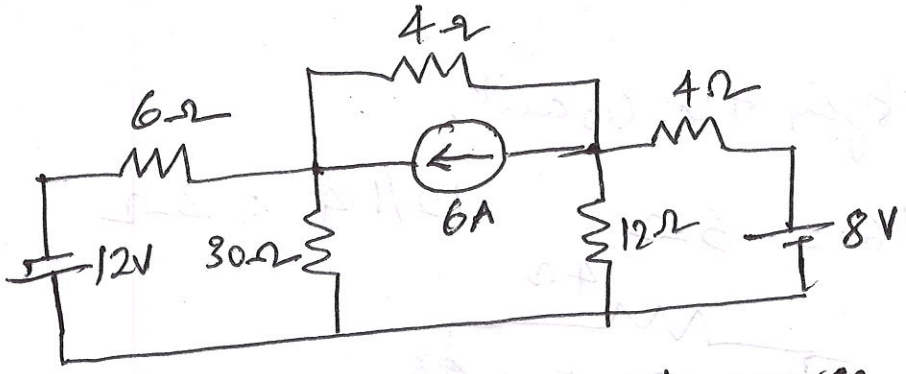
$I = \frac{24}{12} = 2A$

$I_2 = I_1 + I_2 = 2 + 1.17 = \underline{3.17A}$

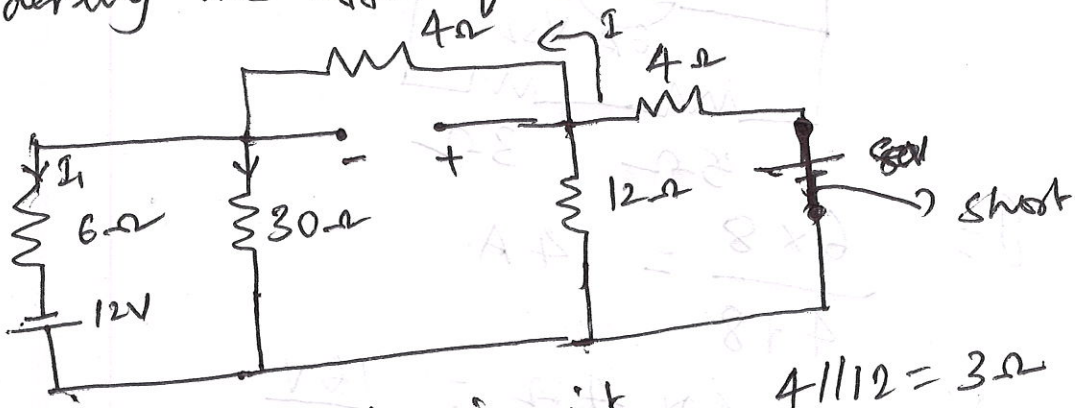
Power delivered by the sources

$P = V \cdot I = 24 \times 3.17 = \underline{76.08\,W}$

6



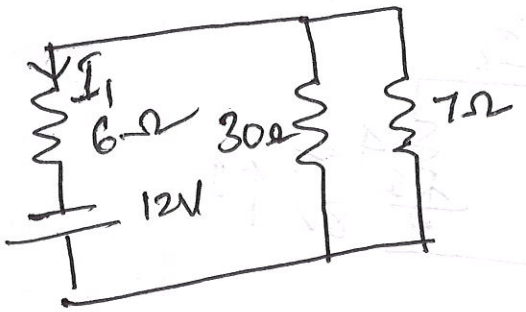
Considering the effect of 12V source



redrawing circuit

$4||12 = 3\Omega$

$4 + (4||12) = 7\Omega$

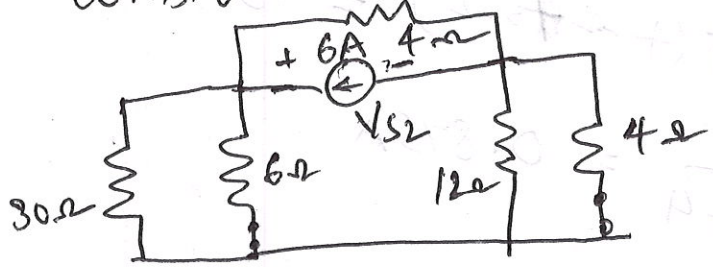


$$I_1 = \frac{12}{6 + (30||7)} = 1.03A$$

$$I = \frac{1.03 \times 30}{7 + 30} = 835.14\ mA$$

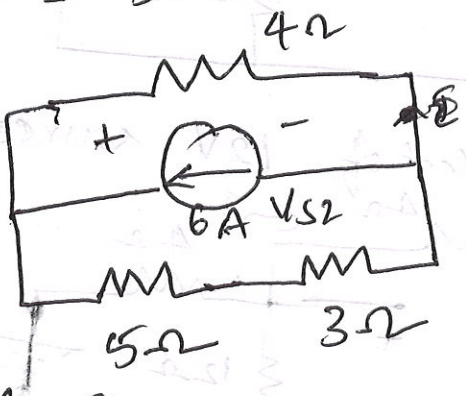
$$V_{s_1} = I \times 4\Omega = 3.34\ V$$

Considering the effect of 6A source:



Simplifying the circuit,

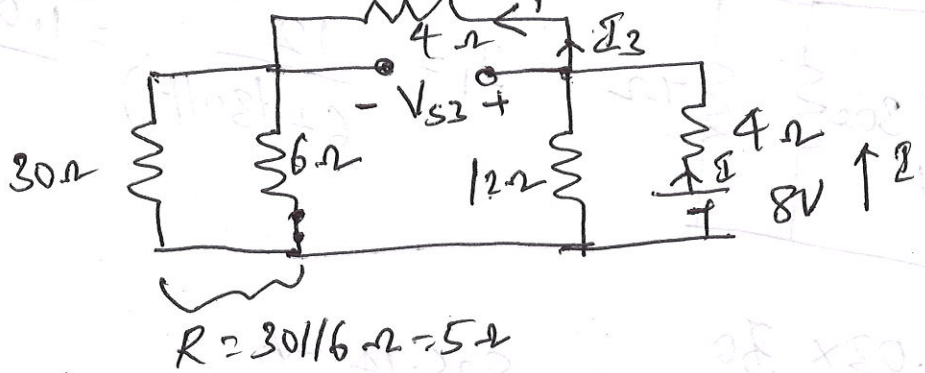
$30 // 6 = 5\Omega$ $\quad 12 // 4 = 3\Omega$



$$I = \frac{6 \times 8}{4+8} = 4A$$

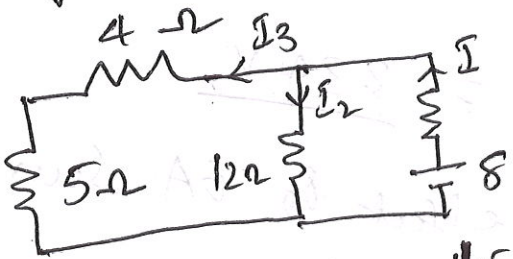
$$V_{S2} = 4A \times 4\Omega = \underline{16V}$$

Considering the effect of 8V source:



$R = 30 // 6\Omega = 5\Omega$

Simplifying the circuit



$$R = 12\Omega \,//\, (4\Omega + 5\Omega) = 5.14\Omega$$

$$I = \frac{8}{5.14+4} = 0.875A$$

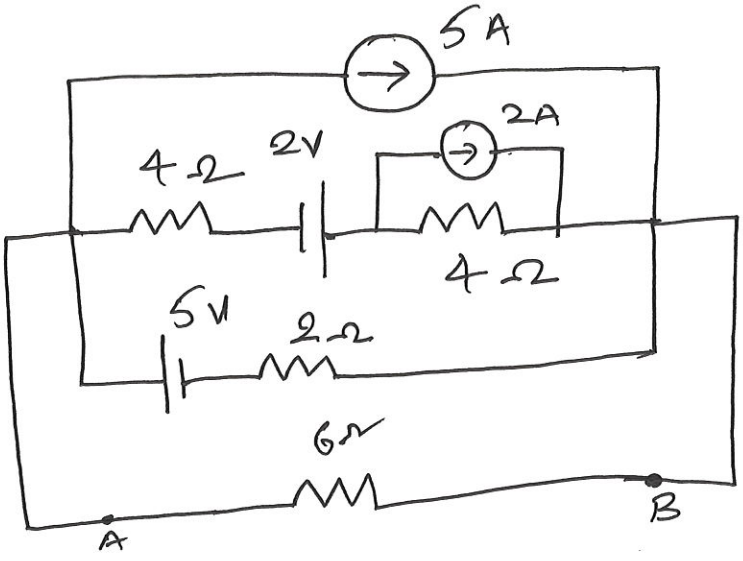
$$I_3 = \frac{12 \times 0.875}{12+9} = 0.5A$$

$V_{S3} = 2V$

$V_S = -V_{S1} + V_{S2} - V_{S3} = -3.34 + 16 - 2$

$= \underline{10.66V}$

7.



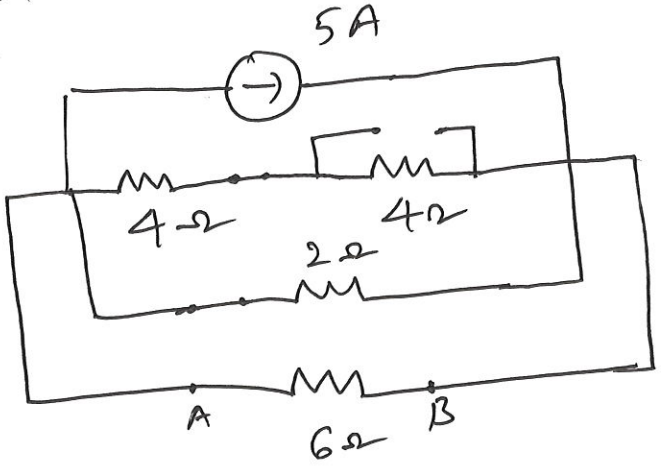
Consider 5A Source.

2A source is open (current source)

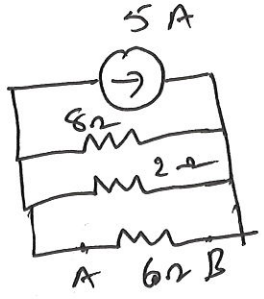
5V Source is short } Voltage Sources.

2V Source is short

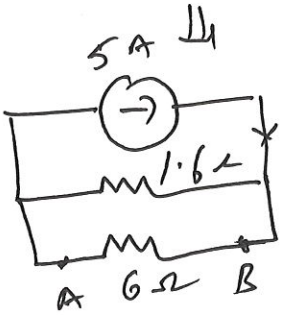
redrawing the Circuit,



=)

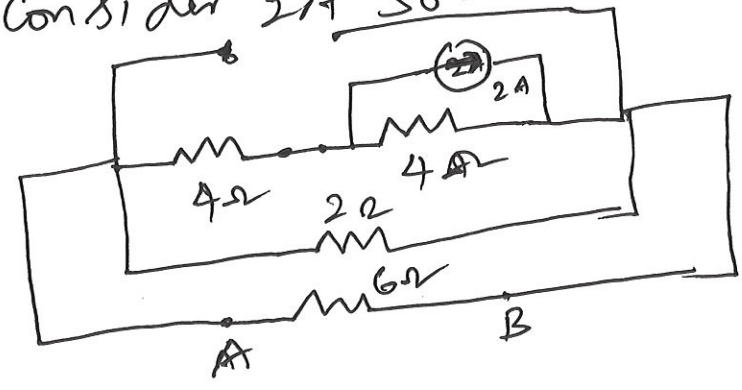


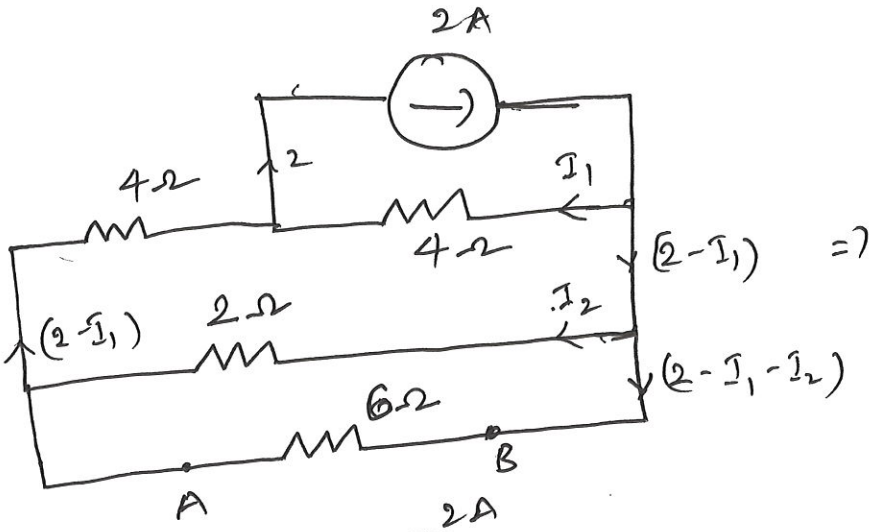
$8\Omega \,||\, 2\Omega = 1.6\Omega$



$$I_{6\Omega}(5A) = \frac{5 \times 1.6}{1.6+6} = 1.05A \text{ (B to A)}$$

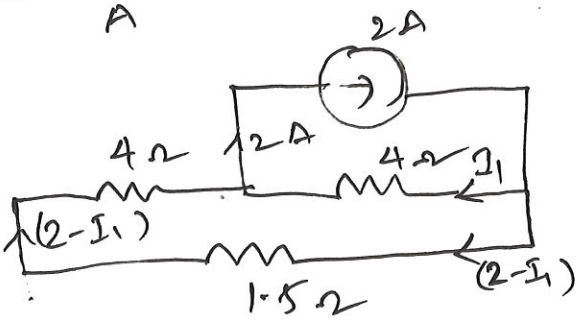
Consider 2A Source





$(2\|6) = \frac{12}{8} = \frac{3}{2}\Omega$

$= 1.5\Omega$



$I_1 = \frac{2 \times 5.5}{4+4+1.5}$

$I_1 = 1.158\,A$

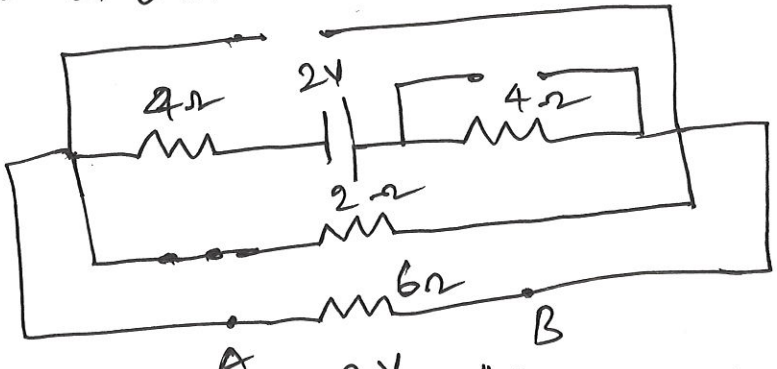
$2 - I_1 = 0.842\,A$

$I_2 = \frac{(2-I_1)\times 6}{6+2} = \frac{0.842 \times 6}{8} = 0.632\,A$

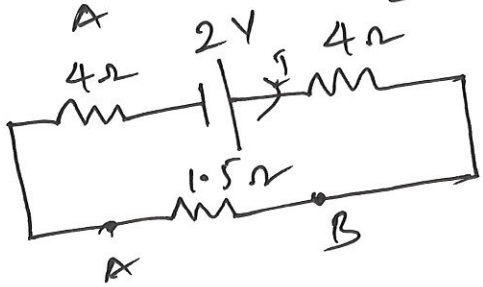
$2 - I_1 - I_2 = 0.21\,A$

$I_{6\Omega}(2A) = 0.21A$ (B to A)

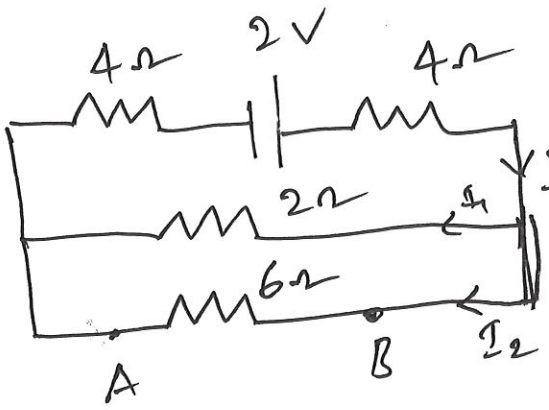
Consider 2V Source



$6\|2 = 1.5\Omega$



$I = \frac{2}{4+4+1.5} = 0.21A$

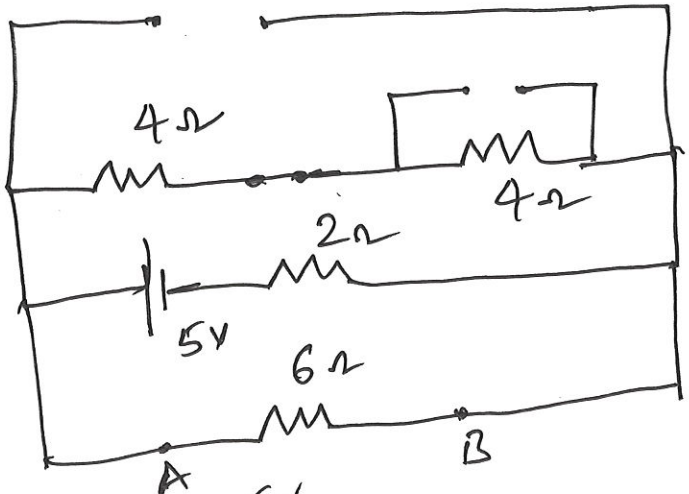


$I = 0.21\,A$

$$I_2 = \frac{0.21 \times 2}{2+8} = 0.042\,A$$

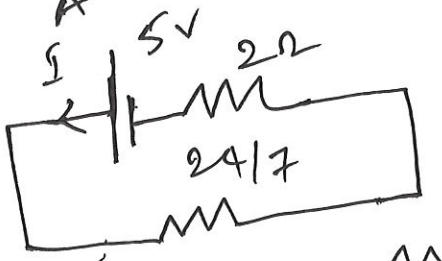
$I_{6\Omega}(2V) = 0.042\,A$ (B to A)

Consider 5V Source

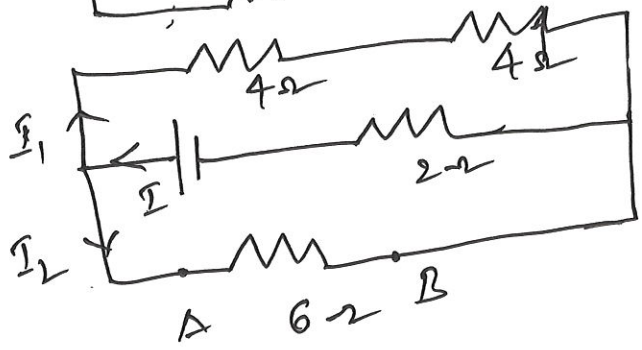


$4+4 = 8\,\Omega$

$8\,\Omega \| 6\,\Omega = \frac{24}{7}\,\Omega$



$I = 0.921\,A$



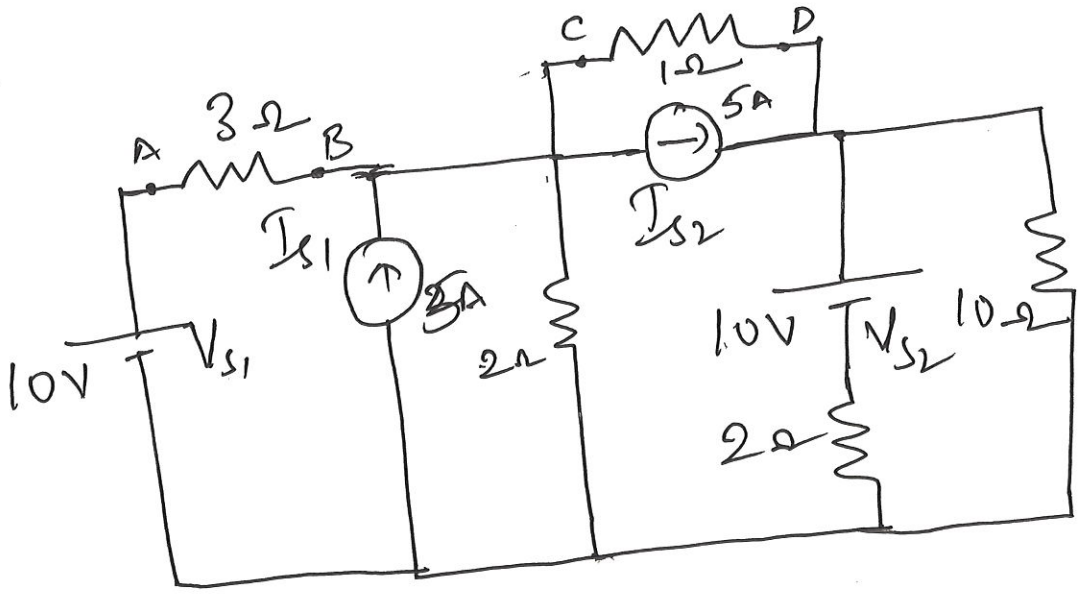
$I_2 = 0.526\,A$ (A to B)

$I_{6\Omega}(5V) = 0.526\,A$ (A to B)

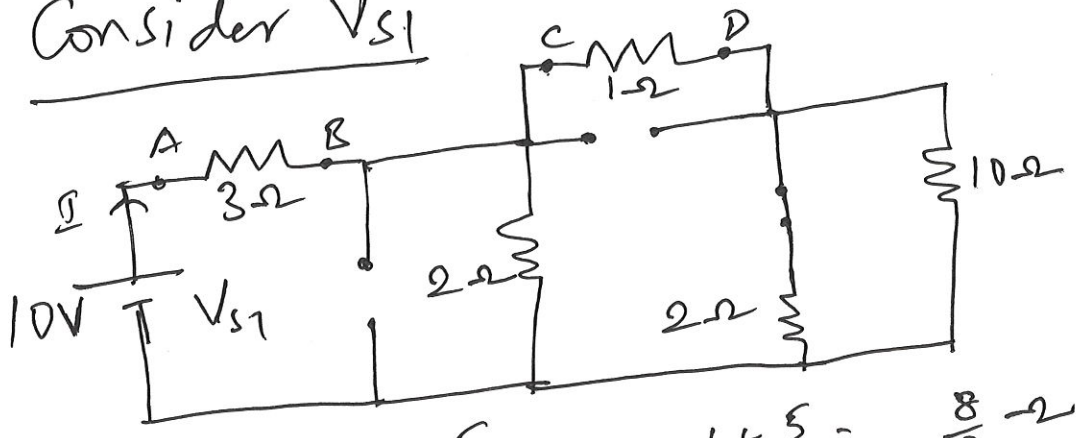
$I_{6\Omega} = 1.05 + 0.21 + 0.042 - 0.526 = 0.776\,A$ (B to A)

$$P = V_{6\Omega} \cdot I_{6\Omega} = I_{6\Omega}^2 \cdot R = \underline{3.61\,W}$$

8.



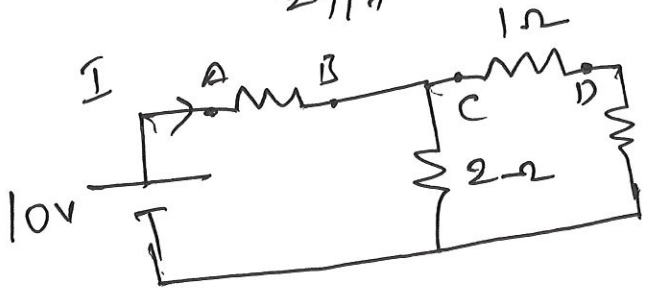
Consider V_{S1}



$2\Omega \,||\, 10\Omega = \frac{5}{3}\Omega$ $\quad 1+\frac{5}{3} = \frac{8}{3}\Omega$

$2\Omega \,||\, \frac{8}{3}\Omega = \frac{8}{7}\Omega$ $\quad \frac{8}{7}\Omega + 3\Omega = \frac{29}{7}\Omega$

$I = \frac{10}{29/7} = 2.41A$ $\quad I_{3\Omega}(10V) = 2.41$ (A to B)

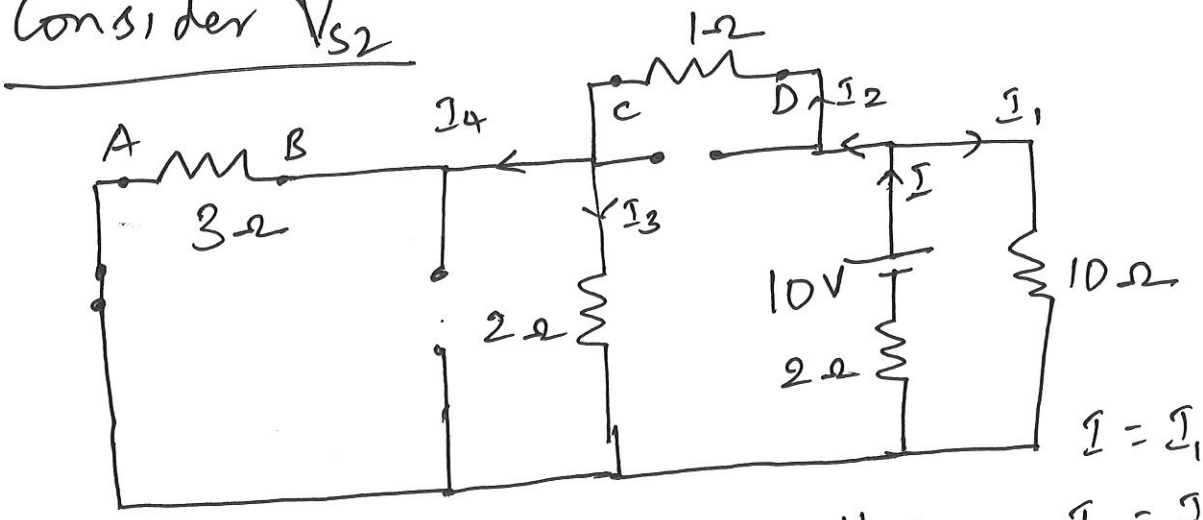


$I_{1\Omega} = \frac{2.41 \times 2}{2+1+5/3}$

$= 1.03A$

$I_{1\Omega}(10V) = 1.03A$ (C to D)

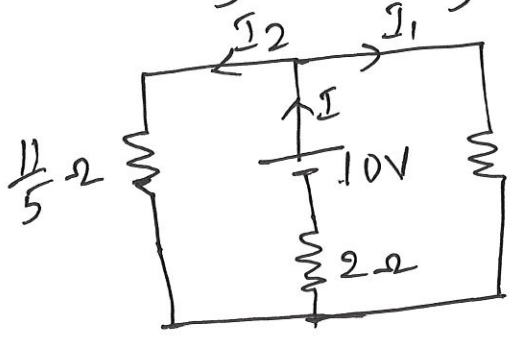
Consider V_{S2}



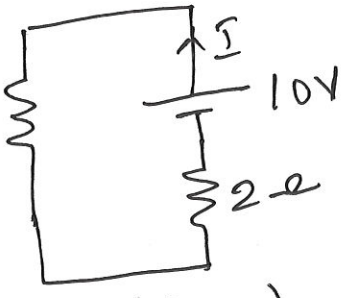
$I = I_1 + I_2$

$I_2 = I_3 + I_4$

$3 \| 2 = \frac{6}{5}\Omega$ $\quad \frac{6}{5} + 1 = \frac{11}{5}\Omega$



$= \frac{110}{61}$

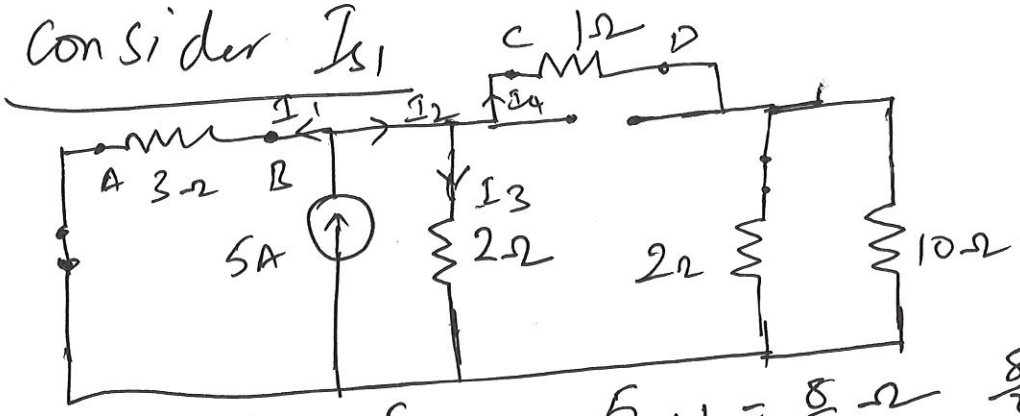


$I = 2.63\ A \left(= \frac{10}{\frac{110}{61} + 2}\ A\right)$

$I_2 = \frac{2.63 \times 10}{10 + 11/5} = 2.16A$ $\quad I_{1\Omega} = 2.16A$ (D to C)

$I_4 = \frac{2.16 \times 2}{2+3} = 0.864A$ $\quad I_{3\Omega} = 0.864A$ (B to A)

Consider I_{S1}



$2 \| 10 = \frac{5}{3}\Omega$ $\quad \frac{5}{3} + 1 = \frac{8}{3}\Omega$ $\quad \frac{8}{3} \| 2 = \frac{8}{7}\Omega$

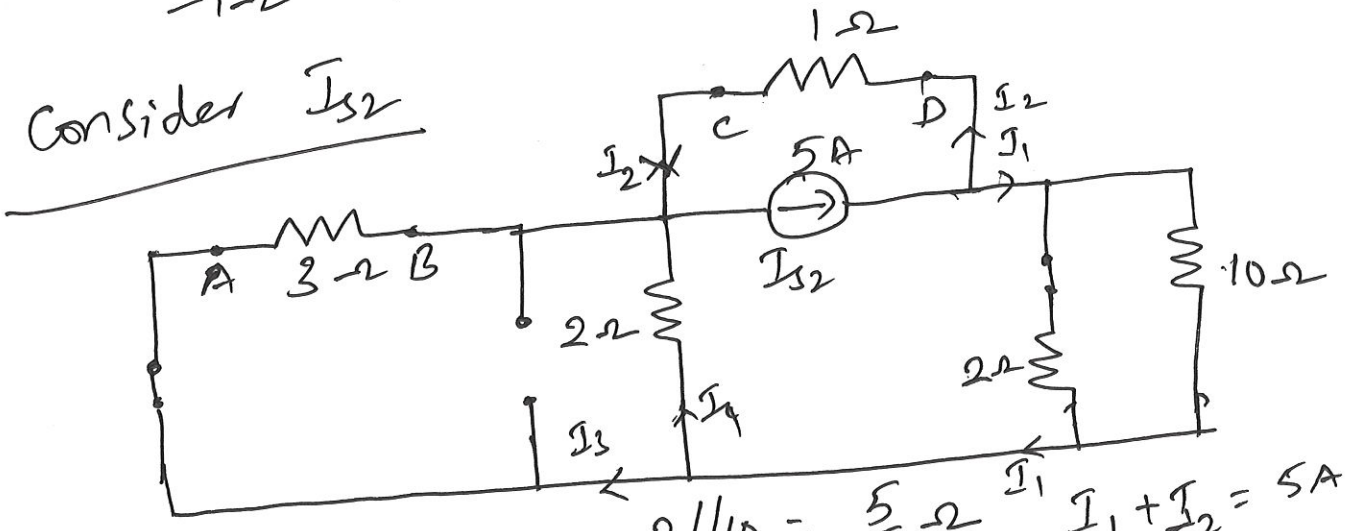
$I_1 = \frac{5 \times 8/7}{3 + \frac{8}{7}} = 1.38\,A$ $\quad I_{3\Omega}(I_{S1}) = 1.38\,A$ (B to A)

$I_2 = 5 - 1.38 = 3.62\,A$

$I_4 = \frac{3.62 \times 2}{2 + 1 + 5/3} = 1.55\,A$ (C to D)

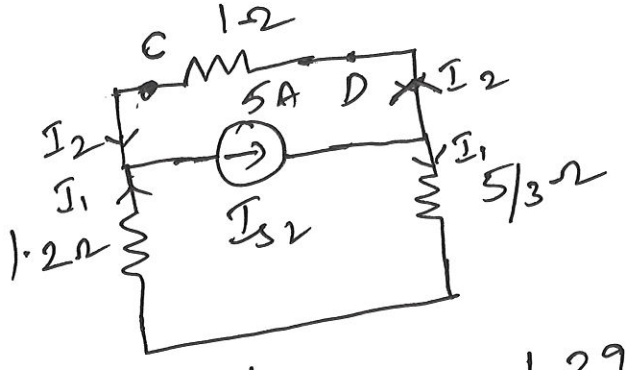
$I_{1\Omega}(I_{S1}) = 1.55\,A$ (C to D)

Consider I_{S2}



$3//2 = 1.2\,\Omega$ $\quad 2//10 = \frac{5}{3}\,\Omega$ $\quad I_1 + I_2 = 5A$

$I_1 = I_3 + I_4$



$I_1 = \frac{5 \times 1}{1 + 1.2 + \frac{5}{3}} = 1.29\,A$

$I_2 = 3.71\,A$ $\quad I_{1\Omega}(I_{S2}) = 3.71\,A$ (D to C)

$I_3 = \frac{1.29 \times 2}{2+3} = 0.516\,A$ $\quad I_{3\Omega}(I_{S2}) = 0.516$ (A to B)

$I_{3\Omega} = 2.41 - 0.864 - 1.38 + 0.516$

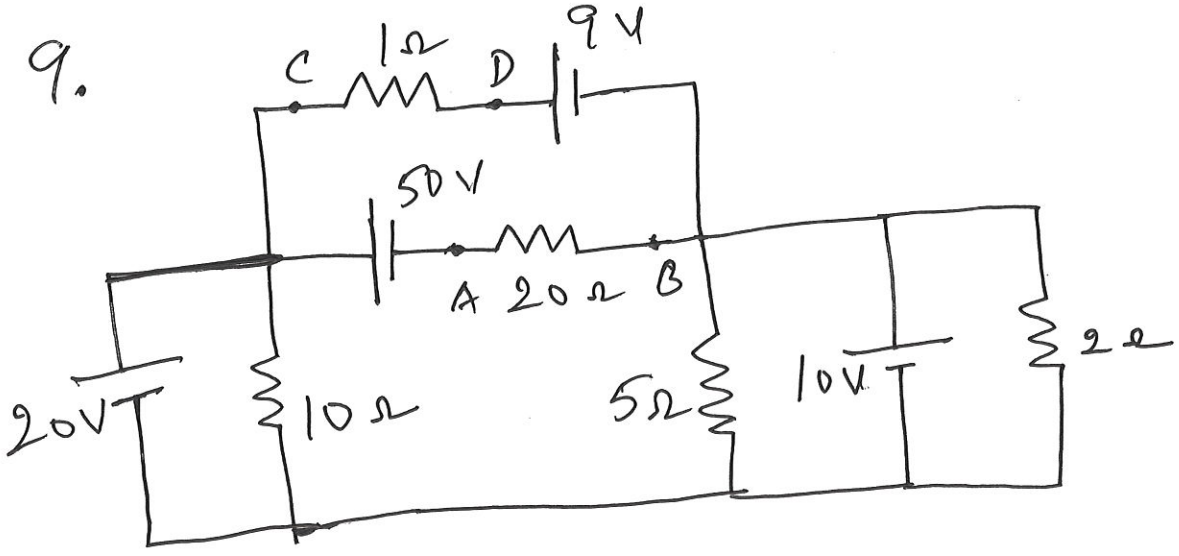
$= 0.682\ A$

$P_{3\Omega} = 1.4\ W$

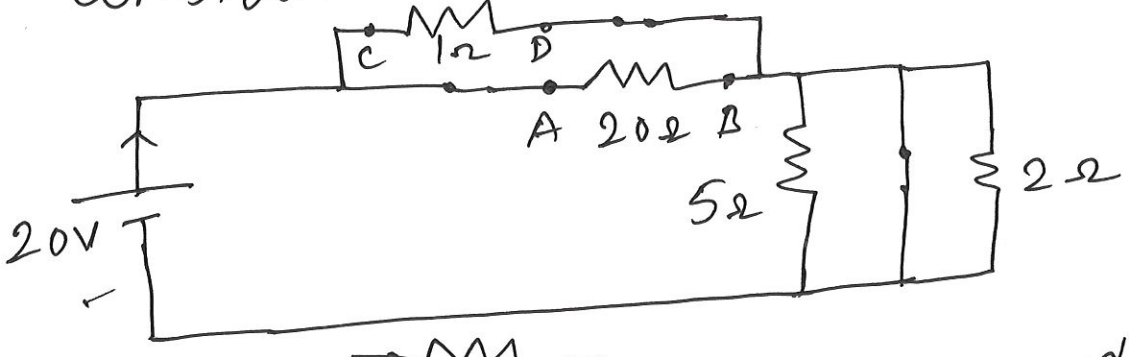
$I_{1\Omega} = 1.03 - 2.16 + 1.55 - 3.71 = -3.29\ A$

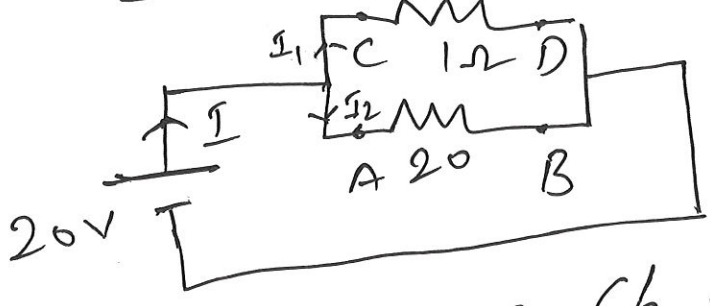
$P_{1\Omega} = 10.82\ W$

9.



Consider 20 V source





$I_1 = \frac{20 \times 20}{21} = 19.05\ A$

$I_2 = 0.95\ A$

$I_{1\Omega}(20V) = 19.05A$ (C to D)

$I_{20\Omega}(20\ V) = 0.95$ (A to B)

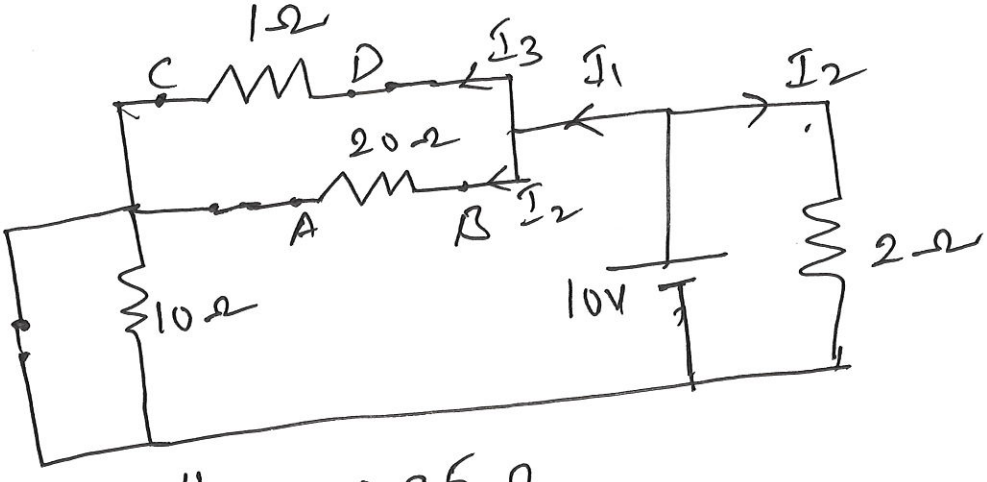
$$I = \frac{20}{20\|1} = \frac{20}{20/21} = 21\ A$$

$$I_1 = \frac{21 \times 20}{21} = 20\ A \qquad I_2 = 1\ A$$

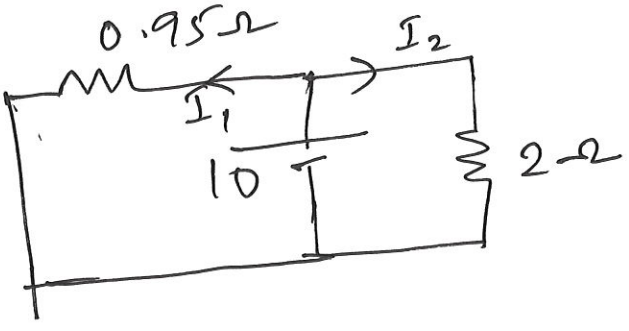
$I_{1\Omega}(20\ V) = 20\ A$ (C to D)

$I_{20\Omega}(20\ V) = 1\ A$ (A to B)

Consider 10V source



$20\|1 = 0.95\ \Omega$



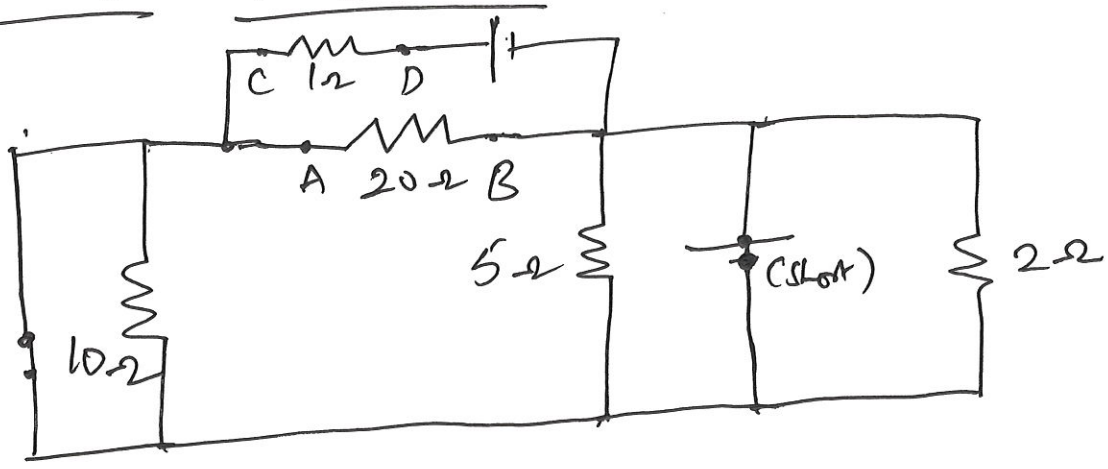
$$I_1 = \frac{10}{0.95} = 10.5\ A$$

$$I_2 = \frac{10.5 \times 1}{21} = 0.5\ A \qquad I_1 = 10A$$

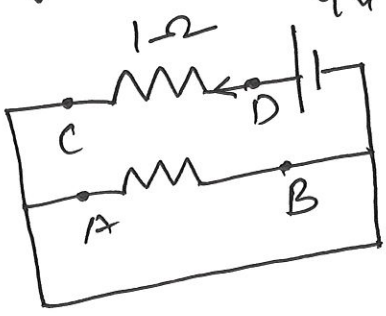
$I_{20\Omega}(10\ V) = 0.5\ A$ (B to A)

$I_{1\Omega}(10\ V) = 10\ A$ (B to C)

Consider 9V Source



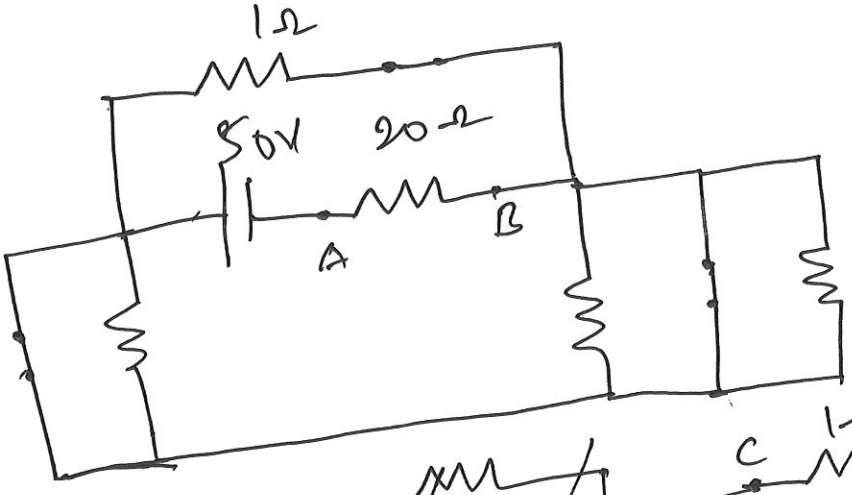
Simplifying,



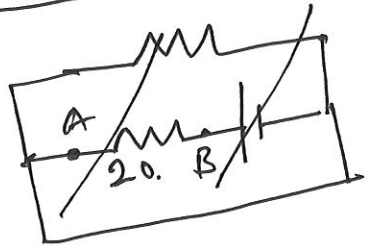
$I_{20\Omega}(9V) = 0\ A$

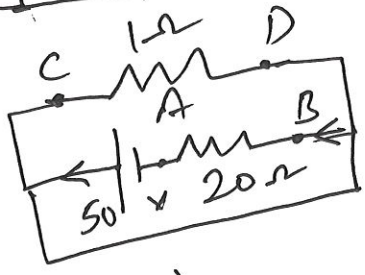
$I_{1\Omega}(9V) = 9\ A$ (D to C

Consider 50V Source



Simplifying





$I_{20\Omega}(50V) = 2.5\ A$ (B to A)

$I_{1\Omega}(50V) = 0\ A$

$$I_{20\Omega} = 1 - 0.5 + 0 - 2.5 = -2\,A$$

$$P_{20\Omega} = 80\,W$$

$$I_{1\Omega} = 20 - 10 - 9 + 0 = 1\,A$$

$$P_{1\Omega} = 1\,W$$