Source Transformation

Source Transformation is another tool for simplifying circuits. we have observed in previous methods of nodal/mesh analysis where in independent voltage and current sources are used. It is therefore, expedient in circuit analysis to be able to substitute a voltage source in series with a resistor for a current source in the parallel with a resistor and vice versa. This is shown in the fig below :—

Independent Sources.

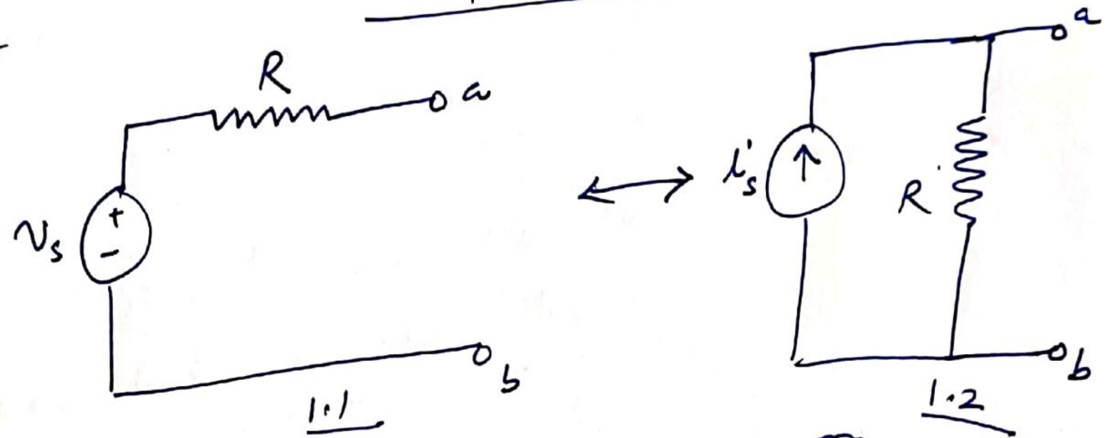

Fig 1.

Transformation of independent sources

A source transformation is the process of replacing a voltage source V_s in series with a resistor R by a current source i_s in ||el with a resistance R or vice versa.

The two circuits in fig 1 are equivalent, provided they have same voltage relationship at terminals a-b. It is easy to show that they are indeed equivalent.

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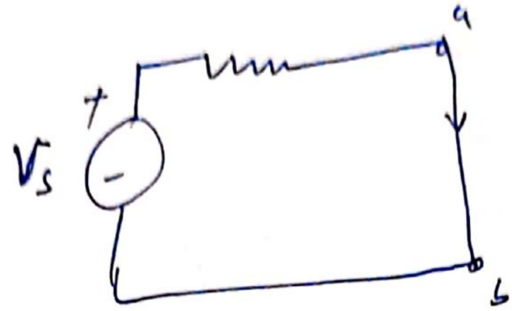
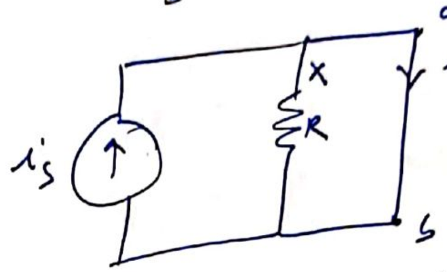
If sources are suppressed; the resistance b/w a & b in both cases is R. $[R_{ab} = R]$

If a & b are shorted, in fig 1.1.



$i_{sc} = \frac{V_s}{R}$;

for fig (1.2).



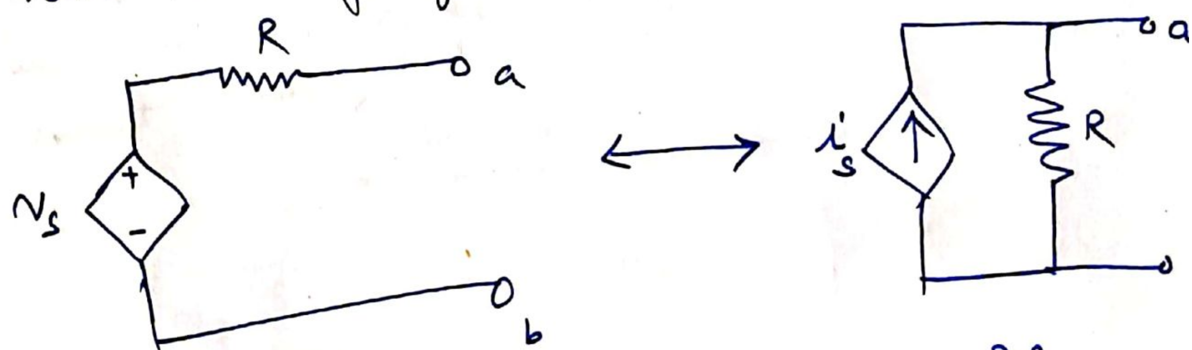
$i_{sc} = i_s$;

Thus $\frac{V_s}{R} = i_s$ for the two circuits to be equivalent of each other.

$\therefore$ $\boxed{V_s = i_s R \quad \text{or} \quad i_s = \frac{V_s}{R}}$

Source Transformation to Dependent Sources.

we have to carefully handle the dependent variable.



2.1 2.2

Fig 2

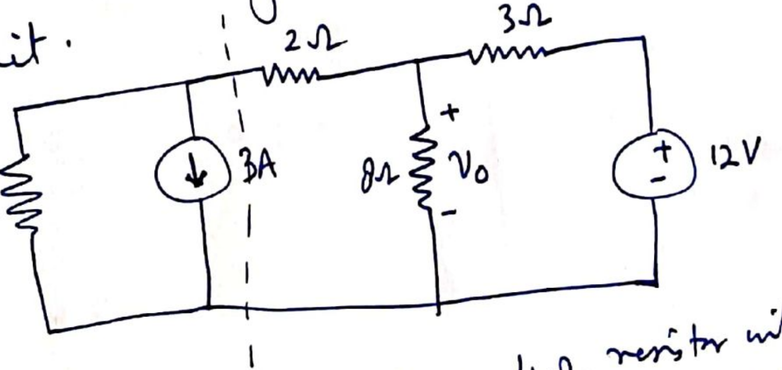
A dependent voltage source in series with resistor can be transformed to a dependent current source in parallel with a resistance or vice versa.

Following points are to be noted.

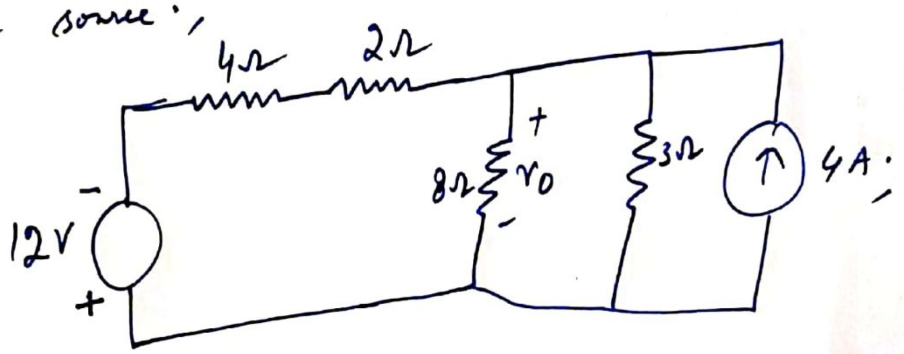
1. The arrow of the current source is directed toward positive terminal of voltage source.

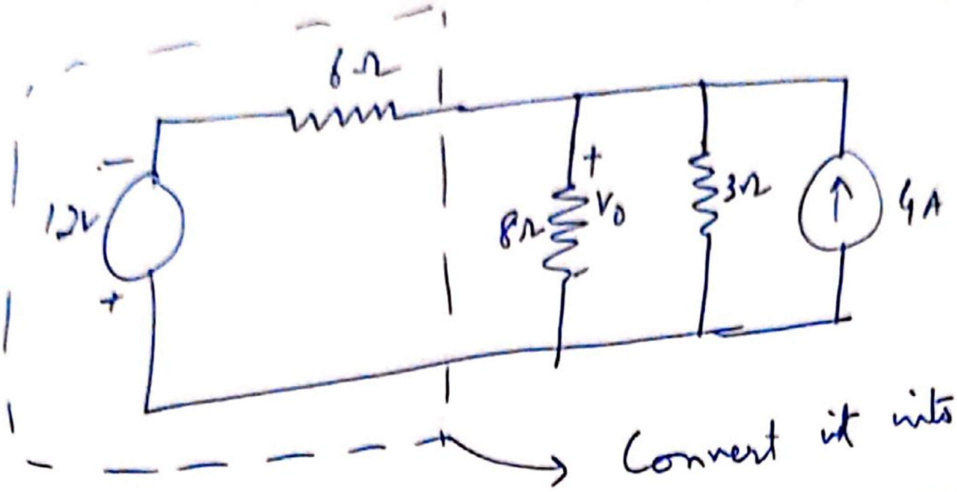
2. Source transformation is not possible when $R = 0$; which is the case with an ideal voltage source;. However, for a practical, non ideal voltage source $R \neq 0$; Similarly, an ideal current source with $R = \infty$ cannot be replaced by a finite voltage source.

<u>Example</u>: Use Source Transformation to find V_o in the following circuit.

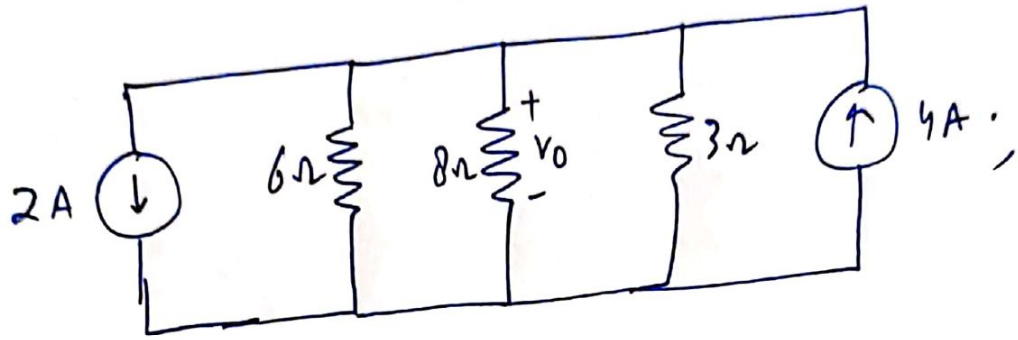


Convert (3A) current source in ||el with 4 Ω resistor into equivalent voltage source; & (12V) in series with 3Ω into current source.





Convert it into Current source;



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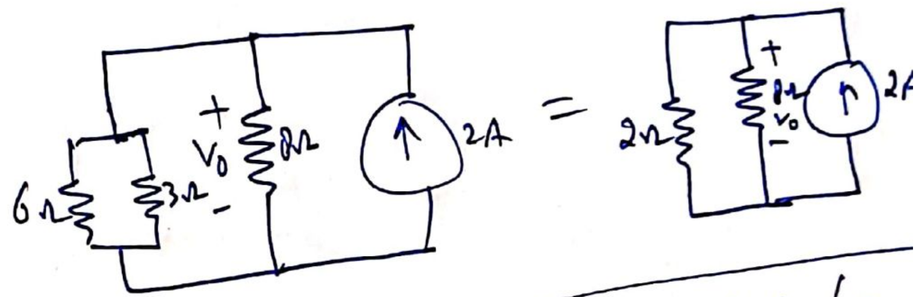


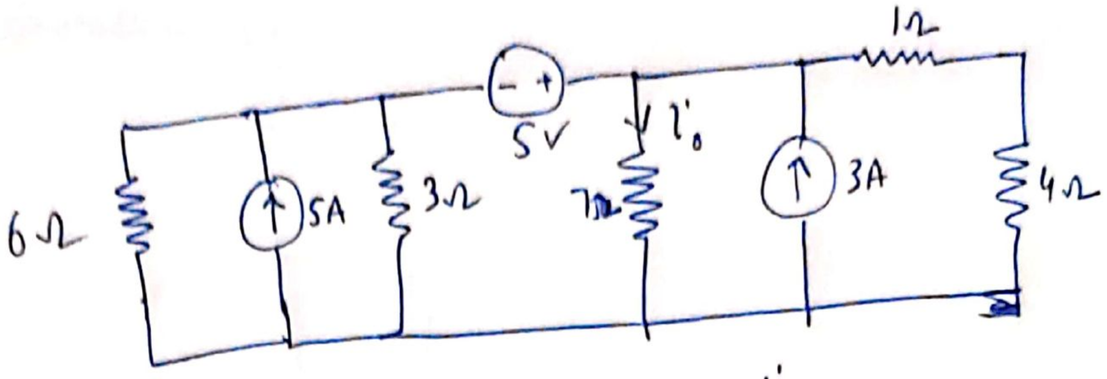
$I_{8\Omega} = 2 \times \frac{\cancel{2}}{\cancel{10}\,5} = 0.4\,A$;

$\therefore v_0 = 0.4 \times 8 = 3.2\,V$.

$v_0 = \frac{8\times 2}{\cancel{10}\,5} \times \cancel{2}$

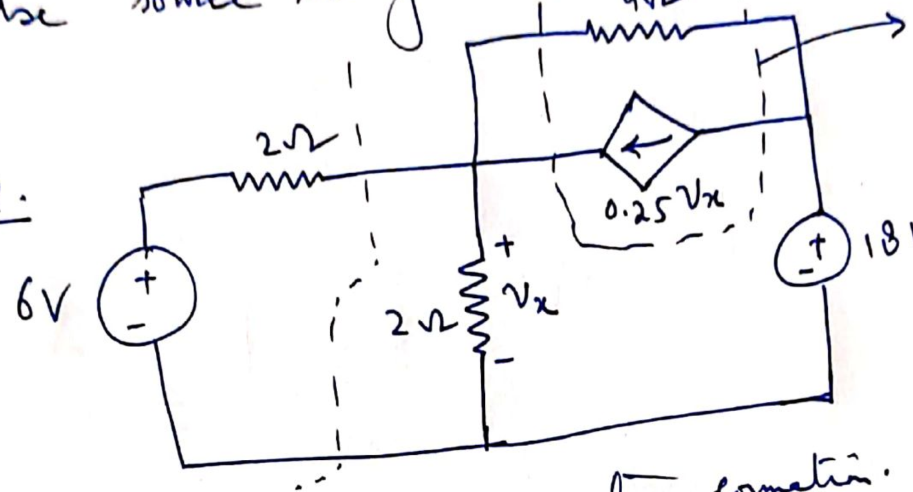
$v_0 = \frac{16}{5} = 3.2$

Example:



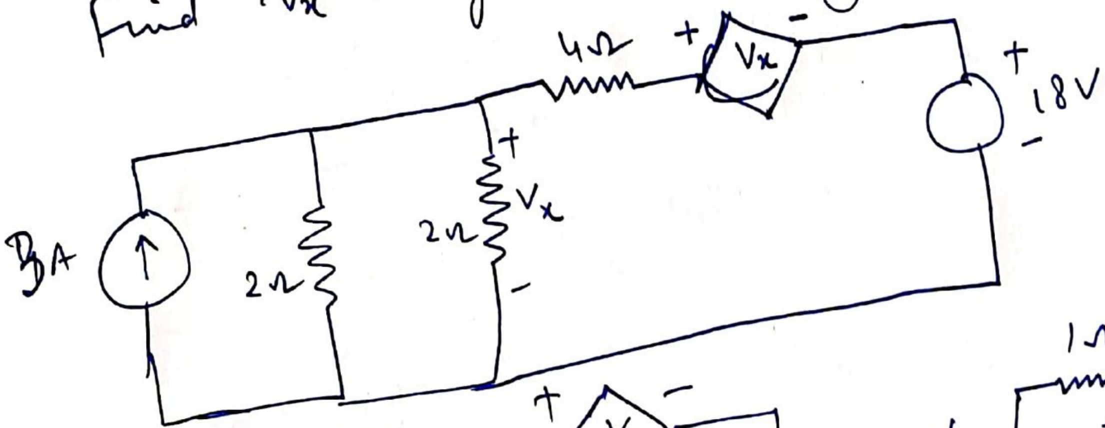
Use source transformation to find i_0.

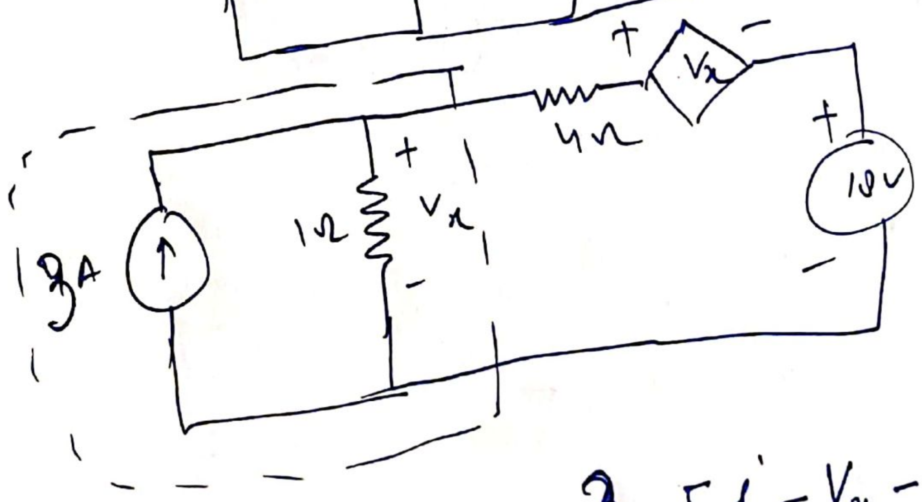
Example.



convert into voltage source.

Find V_x using source transformation.





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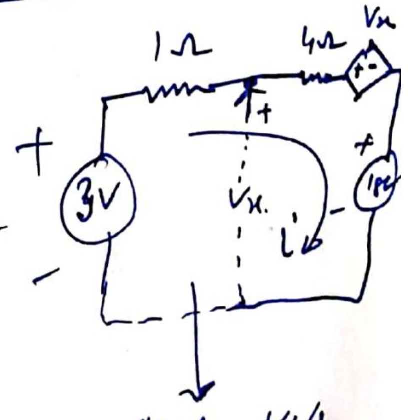


Apply KVL.

$3 - 5i - V_x - 18 = 0$. (1)

Also, $3 - i \times 1 - V_x = 0$

$V_x = 3 - i$;

$\cancel{3} - 5i - \cancel{3} + i - 18 = 0$

$-4i = 18.$

$i = \frac{18}{4} = -4.5\,A$;

$\therefore V_x = 3 - 5i - 18$

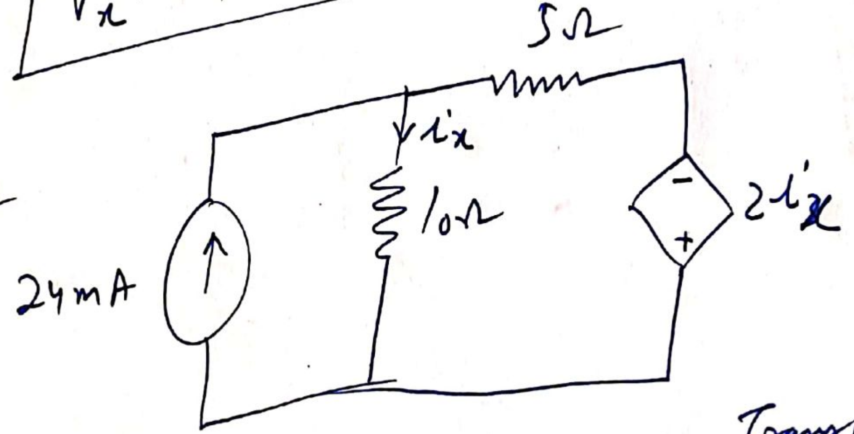
$= 3 - 5 \times (-4.5) - 18$

$= 3 + 22.5 - 18.$

$= 25.5 - 18$

$\boxed{V_x = 7.5\,V}$ Ans.

Exp1 :-



Find i_x using source Transformation.

Answer :- (7.059 mA).