2.2 SOURCE TRANSFORMATION

We have noticed that series-parallel combination and wye-delta transformation help simplify circuits. *Source transformation* is another tool for simplifying circuits. Basic to these tools is the concept of equivalence.

We recall that an equivalent circuit is one whose v-i characteristics are identical with the original circuit. We saw that node-voltage (or mesh-current) equations can be obtained by mere inspection of a circuit when the sources are all independent current (or all independent voltage) sources. 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 parallel with a resistor, or vice versa, as shown in Fig. 2.6.1. Either substitution is known as a source transformation.

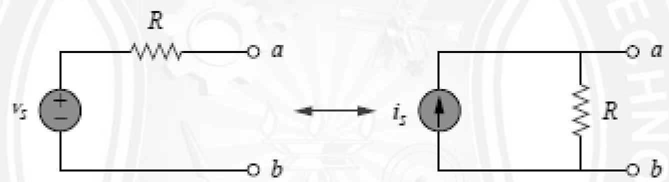

Fig. 2.6.1 Transformation of independent sources.

[Source: "Fundamentals of Electric Circuits" by charles K. Alexander, page: 128]

Statement:

A source transformation is the process of replacing a voltage source vs in series with a resistor R by a current source is in parallel with a resistor R, or vice versa.

Source transformation also applies to dependent sources, provided we carefully handle the dependent variable. As shown in Fig. 2.6.1, a dependent voltage source in series with a resistor can be transformed to a dependent current source in parallel with the resistor or vice versa.

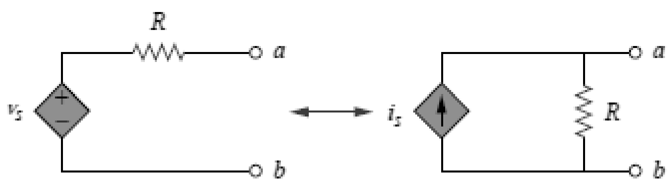

Fig. 2.6.1 Transformation of dependent sources.

[Source: "Fundamentals of Electric Circuits" by charles K. Alexander, page: 128]

Problem 1:

Use source transformation to find Vo in the circuit in Fig

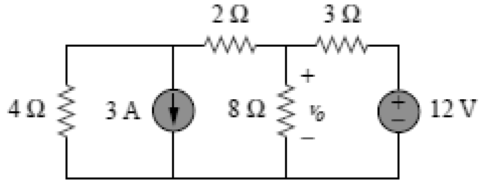

Fig. 2.6.2 For problem 1.

[Source: "Fundamentals of Electric Circuits" by charles K. Alexander, page: 129]

We first transform the current and voltage sources to obtain the circuit in Fig. 4.18(a). Combining the 4Ω and 2Ω resistors in series and transforming the 12-V voltage source gives us Fig. 4.18(b). We now combine the 3Ω and 6Ω resistors in parallel to get 2Ω. We also combine the 2-A and 4-A current source to get a 2-A source. Thus, by repeatedly applying source transformations, we obtain the circuit in Fig. 4.18(c).

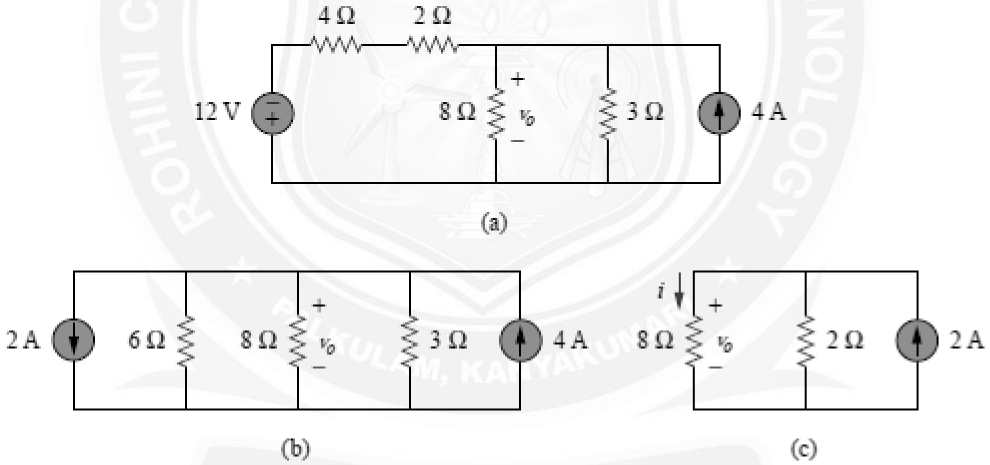

Fig. 2.6.3 For problem 1.

[Source: "Fundamentals of Electric Circuits" by charles K. Alexander, page: 129]

We use current division in Fig2.6.3(c) to get

$$i = \frac{2}{2+8}(2) = 0.4$$

and

$$v_o = 8i = 8(0.4) = 3.2 \text{ V}$$

Alternatively, since the 8-Ω and 2-Ω resistors in Fig2.6.3(c) are in parallel, they have the same voltage v_o across them. Hence,

$$v_o = (8 \parallel 2)(2\text{ A}) = \frac{8 \times 2}{10}(2) = 3.2\text{ V}$$