Indian Institute of Technology Bombay

Dept of Electrical Engineering

Handout 5 | **EE 101 Electrical & Electronic Circuits**

Tutorial 3 | Aug 5, 2011

Question 1) Suppose you are given an electrical network (resistive) with 7 independent current loops for mesh analysis. These mesh currents are known to specify all the branch currents of the network. On inspection, you found that there are 4 sources, and all of them are independent current sources. Let us name the sources as $I_{s_1}, I_{s_2}, I_{s_3}$ and I_{s_4}

a) What is the minimum number of equations that you need to solve to find a set of independent mesh currents.

b) Denote the answer from the previous part as k. So we need to find k mesh currents, say $I_1, I_2, \cdots, I_k$. Show that $I_1, \cdots, I_k$ can be evaluated as the solution of

$$A \begin{bmatrix} I_1 \\ I_2 \\ \cdot \\ \cdot \\ I_k \end{bmatrix} = B \begin{bmatrix} I_{s_1} \\ I_{s_2} \\ I_{s_3} \\ I_{s_4} \end{bmatrix}$$

where A and B are appropriately chosen matrices. In particular, you should specify the following.

1. Write the dimensions of A and B.
2. What are the diagonal entries of A?
3. What is $|A_{ij}|$? i.e. the magnitude of the entry of A at position (i, j).
4. What is $|B_{ij}|$? i.e. the magnitude of the entry at (i, j).

Question 2) Find the Thevenin equivalent of the circuit shown in Figure 2, between points A and B. From this, deduce the current that flows through the 12Ω resistance when a load of 20Ω is connected between A and B.

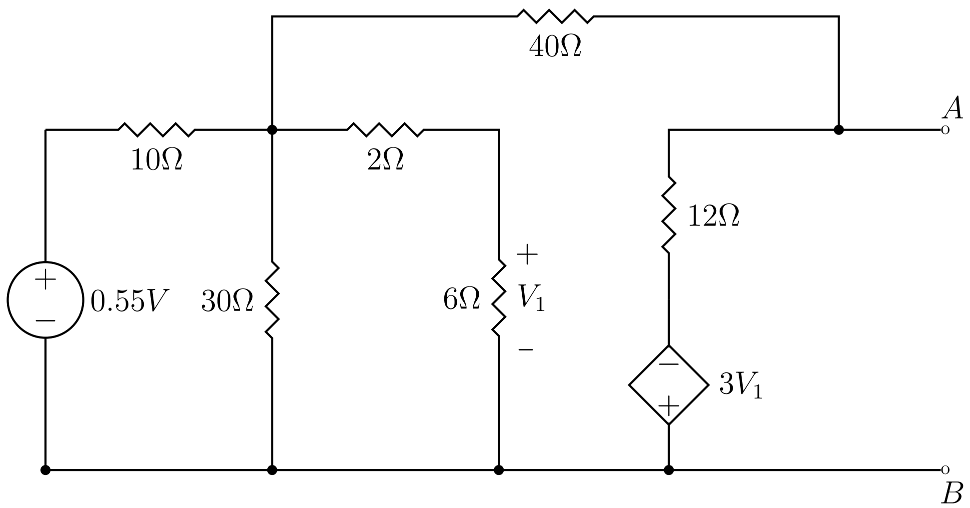

Figure 2

Question 3) Find the voltage across the $2k\Omega$ resistor by using Thevenin's theorem in Figure 3.

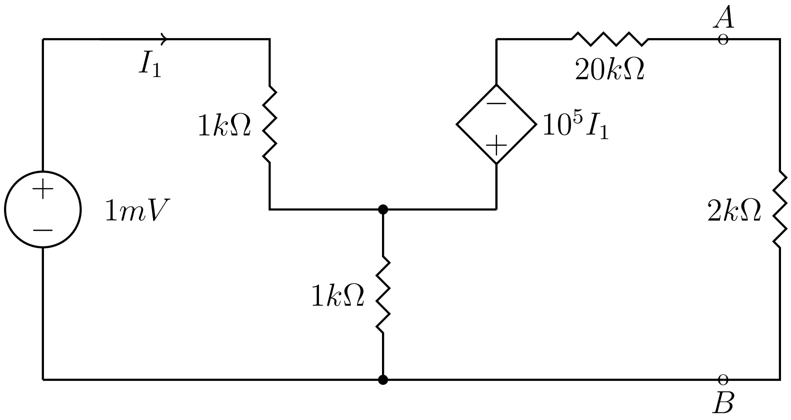

Figure 3

Question 4) This question throws light into some of the intricacies that we usually neglect about Thevenin's theorem. In particular, can any network be written as the series connection of an appropriate voltage source and a resistance?. Think for a moment. What if the network is simply a current source. One may argue that no network reduction is required in this case. But at times, a complex circuit can represent a pure current source, and in this case a Thevenin's representation will be out of question. However, Norton's theorem can work in this case, with zero parallel resistance. This problem illustrates this. Show that the circuit in Figure 4 is nothing but an ideal current source, and find the Norton equivalent.

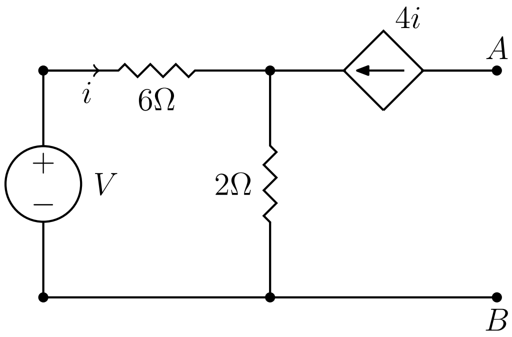

Figure 4

Question 5) This question also shows a tricky situation where there is no independent source in the network. So currents and voltages are essentially zero as such. Thevenin's and Norton's theorems still apply, thus effectively getting a zero source value and a resistor. Find the Norton equivalent of the circuit in Figure 5.

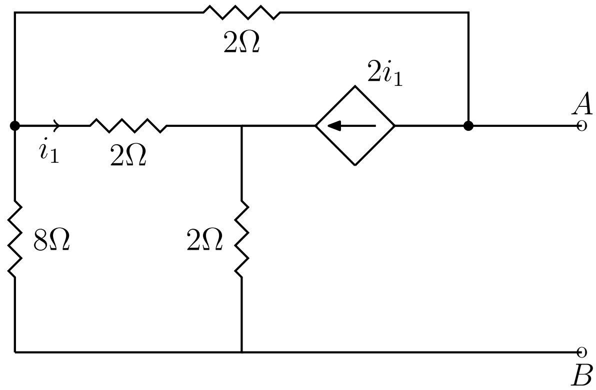

Figure 5

Question 6) Find the Norton equivalent circuit between terminals A and B of Figure 6.

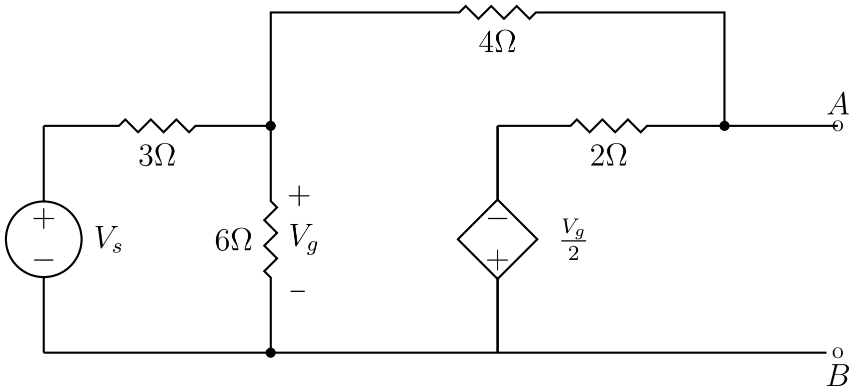

Figure 6