Week 5: EGB120 lecture notes

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1 Non-Ideal Source

- Real sources often have many limitation in the term of voltage and current delivery.
- The most commonly modelled, and most useful for a lenear circuit theory, is some form of resistance associated with the source

2 Thévenin Equivalent

- The Thé venin equivalent circuit is a voltage source with series resistance.
- characterised by the three related parameters: v_{Th}, R_{Th}, and i_{sc}.

2.1 Formula

$$i_{scc} = \frac{v_{Th}}{R_{Th}} \tag{1}$$

Figure 1: Thévenin formula

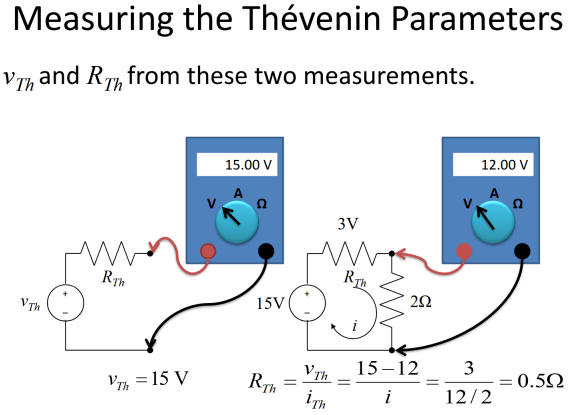


Figure 2: Thev calculations

3 Norton Equivalent

- You can equally use a current source with a resistor in parallel to get exactly the same properties.
- This is called equivalent circuit.

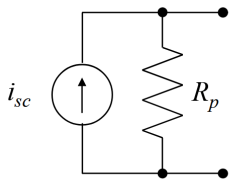


Figure 3: Nortorn equivalent

4 Thévenin Equivalent<=> Nortorn Equivalent

- You can substitute a Thévenin Equivalent-circuit for a Norton equivalent circuit and vice versa
- Calculating equivalent component values required no extra info:

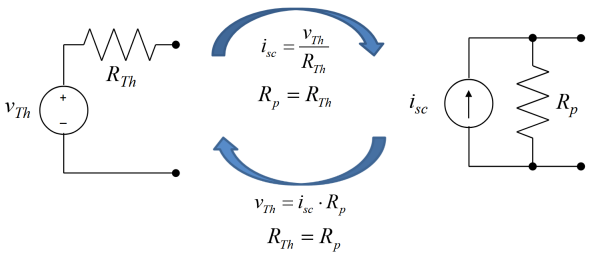


Figure 4: Thévenin Equivalentand Norton relationship

5 Superposition

1. Superposition is a principal of linear systems.
2. We can use it to simplify circuit analysis by noting that we can treat each source independently.
3. Circuits can be simplified by having only one source active at a time, changing all the other sources to zero.
4. Net effect on the coltage or current can be found by the summing components due to individual sources.

5.1 Conditions

1. For a **current source**, changing to zero means replacing it with an **open circuit** (zero current, whatever voltage).
2. For a **voltage source** changing to zero means replacing it with a **short circuit** (zero voltage, whatever current).
3. Work out total voltage or current from the sum of the individual contributions.

5.2 Example calculations

- Lets find voltage at node *a* by superposition.
- First find contribution from voltage source (open circuit cur source).

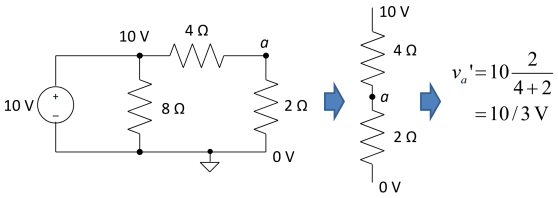


Figure 5: Step (1)

- Contribution from voltage source $v_a' = 10/3$ V
- Now find contribution from current source (short circuit voltage source).

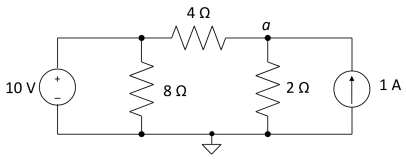


Figure 6: Step (2)

- Contribution from voltage source $v_a' = 10/3$ V
- Now find contribution from current source (short circuit voltage source).

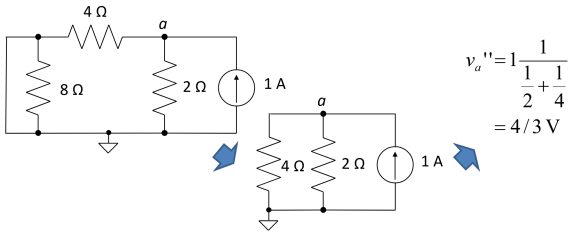
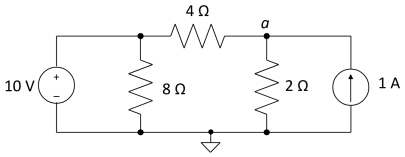


Figure 7: Step (3)

- Contribution from voltage source. $v_a' = 10/3$ V
- Contribution from current source. $v_a'' = 4/3$ V
- Therefore $v_a = v_a' + v_a'' = 14/3$ V



6 Thévenin's Theorem

- Any linear circuit can be replaced by a voltage source and a resistance.
- Find v_{Th} from the open circuit voltage.
- Find the short circuit current i_{sc} and then $R_{Th} = v_{Th} / i_{sc}$ **or ...**
- Find R_{Th} from the resistance with all sources set to 0 (often easier)

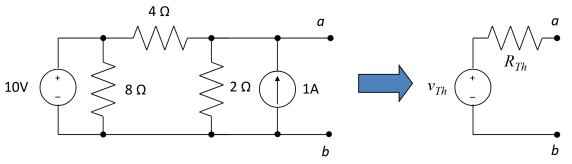


Figure 8: Step (1)

- We know v_{Th} = 14/3 V from our previous working on this circuit.
- Now set all sources to 0 and find R_{Th}.

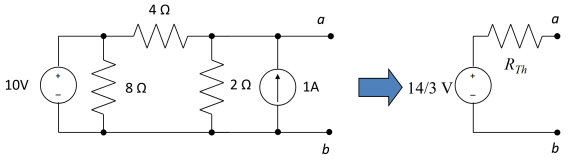


Figure 9: Step(2)

- Replace voltage source with short circuit, and current source with open circuit.
- $R_{Th} = 2\ \Omega \,||\, 4\ \Omega = 4/3\ \Omega$
- So what is the Norton equivalent? (v_{Th} = 14/3 V)

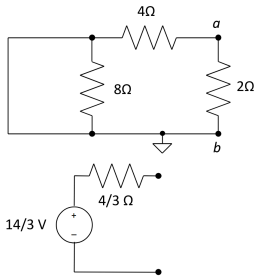


Figure 10: Step (3)

7 Northon Theoren

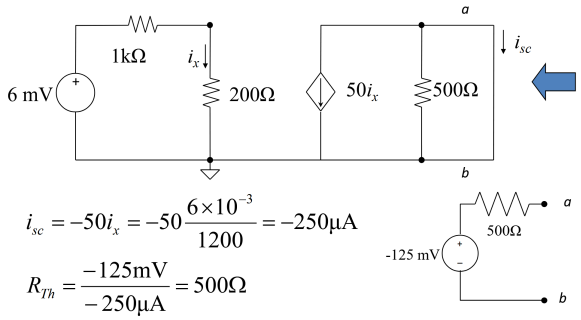


Figure 11: Sample calculations of Notorn Theorem