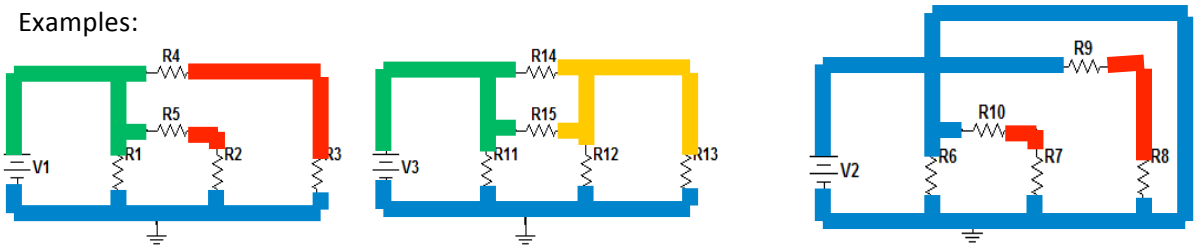
ECE1250 Cookbook – Nodes, Series, Parallel

- How to identify electric nodes, and if they are ordinary or extraordinary.
- How to identify which combinations of resistors are in series and parallel?
- How to determine which resistors can be eliminated because they are in parallel with a short circuit.

1) **Identify all electrical components in your circuit:** Electrical components include voltage and current sources, resistors, capacitors, inductors, diodes, op amps, transistors, etc. A wire or junction of wires is NOT a component.
2) **Identify nodes**: A node is any region/combination of wires that connects electric components. Start at one electrical component, and 'color in' every wire & junction that connects it to other components. A node has the same voltage everywhere on that node. (If you have a short circuit, you may find that many different parts of your circuit are all joined as one large node.)

Examples:



3) **Identify if the nodes are ordinary (red) or extraordinary** (blue,yellow,green,etc.). If a node connects only TWO elements, it is ordinary. These nodes are red in the examples above. If a node connects more than two elements, it is extraordinary.
4) **Identify which components are in series.** If two components are connected by an ordinary (red) node, they are in series. **If several components are connected in a line, with only ordinary nodes between them, they are all in series. One convenient way to indicate two (or more) resistors are in series is to put a dash between them.** R2-R5 , R3-R4, R7-R10, R8-R9 for example. The order in which you list series resistors doesn't matter. (R2-R5 is the same as R5-R2). Resistors in series have the same current passing through them.
5) **Identify which components are in parallel.** If two (or more) components are in parallel, they both share the same colors on either end of the component. **One convenient way to indicate two resistors are in parallel is to put a || between them.** R14||R15, R12||R13, V1||R1, V3||R11, V2||R6 for example. The order in which you list parallel resistors doesn't matter. (R14||R15 is the same as R15||R14). Resistors in parallel have the same voltage across them.
6) **Identify combinations of components that are in series and/or parallel:** Combinations of resistors can also be said to be in series or parallel. First, identify the individual components that are in series or parallel (steps 4,5). Then, treat each of those series/parallel combinations as if they were individual resistors, and consider their combinations with other resistors. This is a little hard to explain, so let's look at the examples above:

Circuit 1: R2-R5 , R3-R4, R1 || (R2-R5) || (R3-R4)

By putting (parentheses) around components, we can indicate if they are series groupings, and then parallel, or the other way round. This matters.

In 'Engineering Speak', we say: "R1 is in parallel with the series combinations of R2 and R5, and R3 and R4."

Circuit 2: R14||R15, R12||R13, (R14||R15) - (R12||R13) R11||{ (R14||R15) - (R12||R13) }

"R11 is in parallel with the series combination of R14andR15 in parallel and R12andR13 in parallel." (Ok, at about this point, you better draw the circuit diagram for the person you are talking with….the spoken description gets confusing quickly.)

7) How to handle short circuits: Short circuits (we often just call these 'shorts'), such as the one shown in Circuit 3, are any wire or other conductor that connects two or more circuit elements. Any wire is technically a short circuit, but *usually* when we talk about a short circuit, we are talking about a wire/conductor that is in parallel with other elements of the circuit and 'shorts them out'.

a) Identify nodes in the circuit as in step 1. The short circuit MAY connect many parts of the circuit, such as the voltage source and ground in this example. Just 'color in' (in this case, in blue) the wires/conductors until you reach all of the circuit elements they are attached to.

b) Identify components that are in series and parallel, as in steps 5,6. In this case, the short circuit may be treated as a component, particularly in 'Engineer Speak'. For example:

Circuit 3: R7-R10, R8-R9, R6|| (R7-R10) || (R8-R9) || short circuit

c) Any component (except voltage and current sources) in parallel with a short circuit is 'shorted out'. No current will pass through it, because all the current will go through the short. All components (except voltage and current sources) in parallel with a short can be removed from the circuit. You can remove all of the resistors in Circuit 3. The voltage source is effectively shorted out which means it will attempt to *source or drive infinite current* into the short. Hopefully the circuit has a fuse or circuit breaker that will open to prevent the current from *running away* (going to infinity) and burning up the circuit.