Splitting Rule

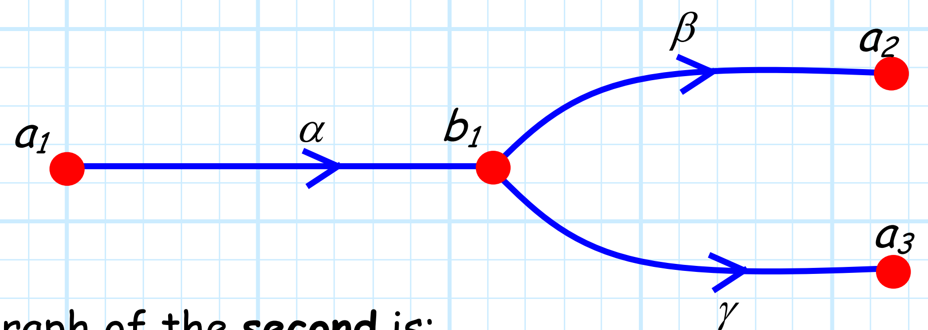
Now consider these **three** equations:

$$b_1 = \alpha\, a_1 \qquad a_2 = \beta\, b_1 \qquad a_3 = \gamma\, b_1$$

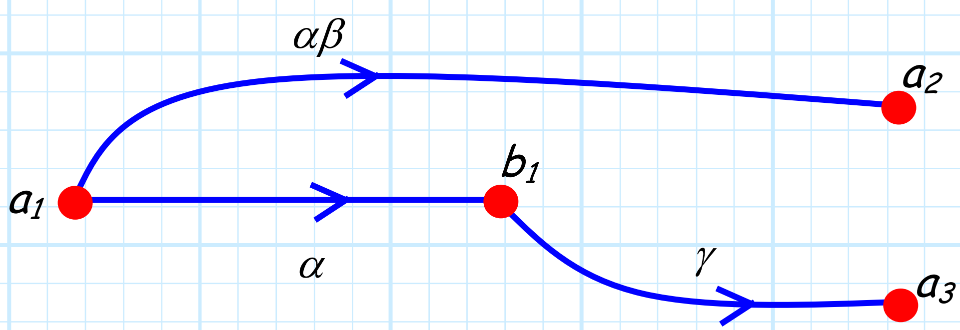
Using the **associative property,** we can likewise write an equivalent set of equations:

$$b_1 = \alpha\, a_1 \qquad a_2 = \alpha\beta\, a_1 \qquad a_3 = \alpha\, b_1$$

The signal flow graph of the **first** set of equations is:



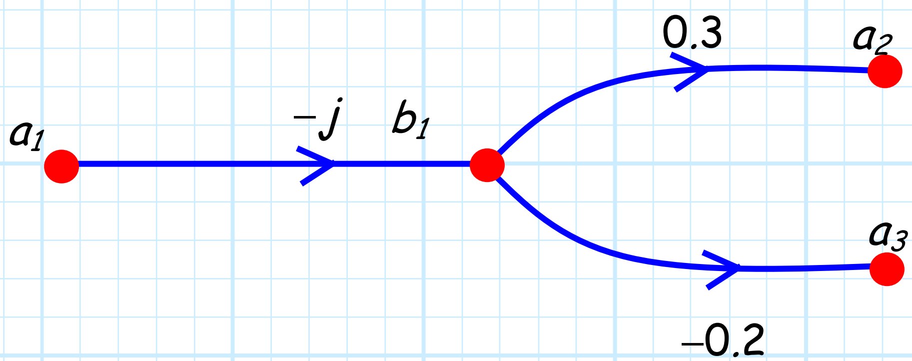
While the signal flow graph of the **second** is:



Rule 4 – Splitting Rule

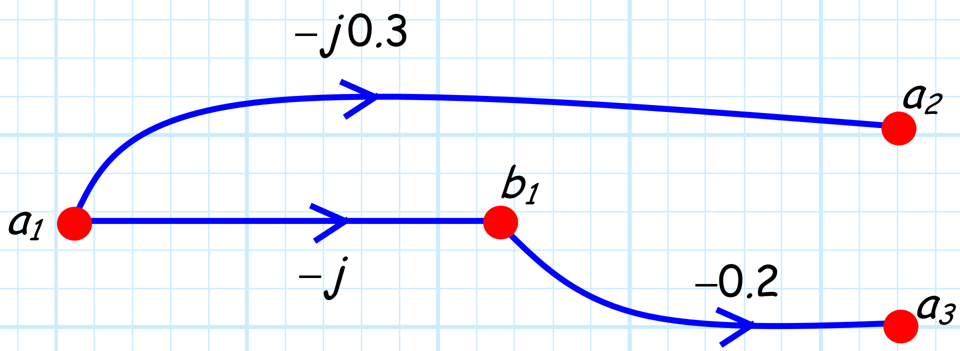
If a node has one (and only one!) incoming branch, and one (or more) exiting branches, the incoming branch can be "split", and directly combined with each of the exiting branches.

For example:



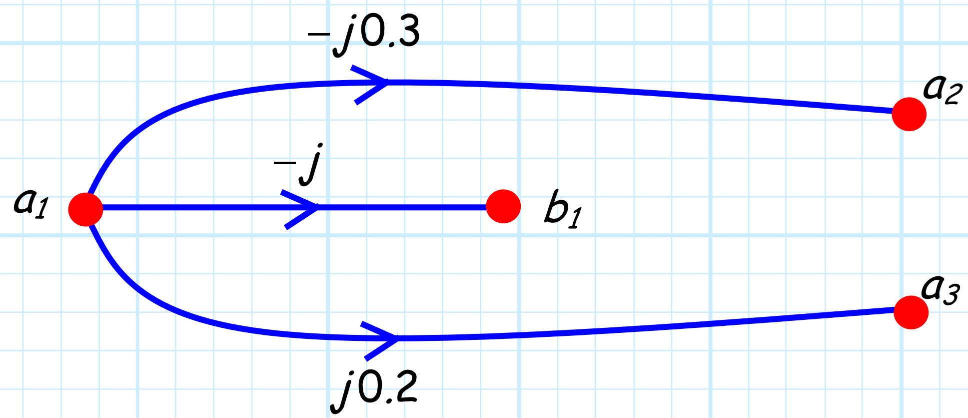
$$b_1 = -j\ a_1$$
$$a_2 = 0.3\ b_1$$
$$a_3 = -0.2\ b_1$$

can be rewritten as:



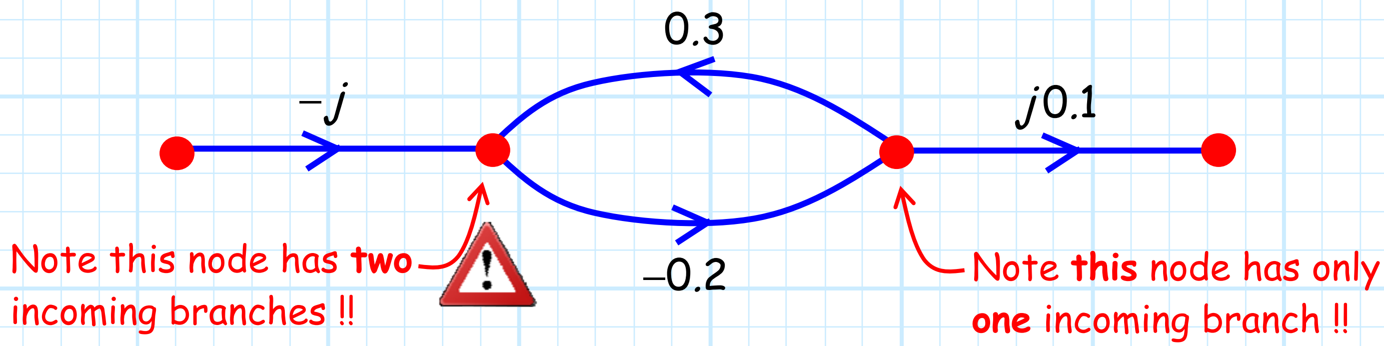
$$b_1 = -j\ a_1$$
$$a_2 = -j0.3\ a_1$$
$$a_3 = -0.2\ b_1$$

Of course, from rule 1 (or from rule 4!), this graph can be **further** simplified as:

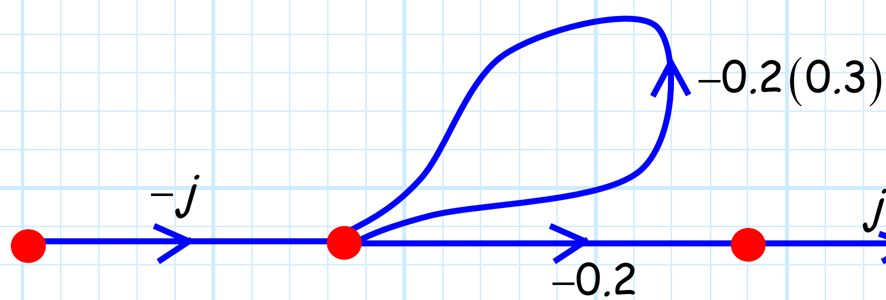


$$b_1 = -j\ a_1$$
$$a_2 = -j0.3\ a_1$$
$$a_3 = j0.2\ a_1$$

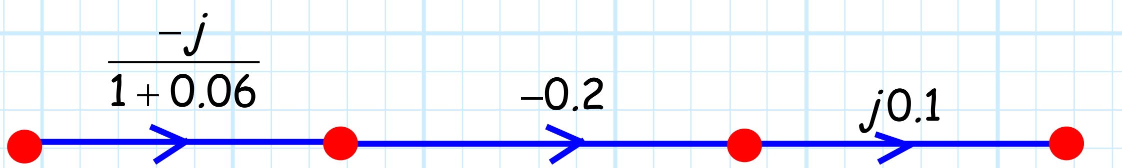
The splitting rule is **particularly useful** when we encounter signal flow graphs of **the kind**:



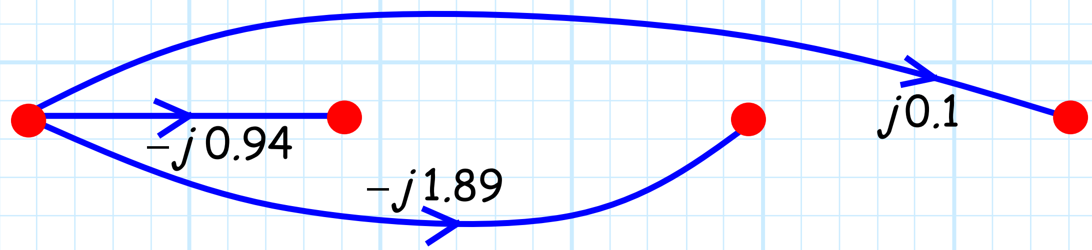
We can **split** the -0.2 branch, and rewrite the graph as:



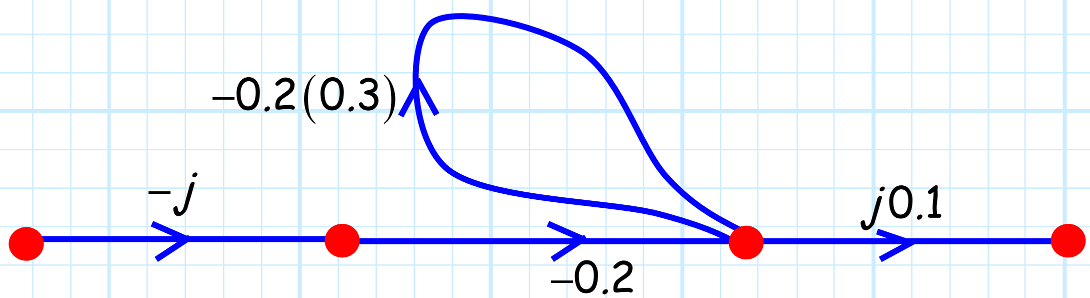
Note we now have a **self-loop**, which can be eliminated using **rule #3**:



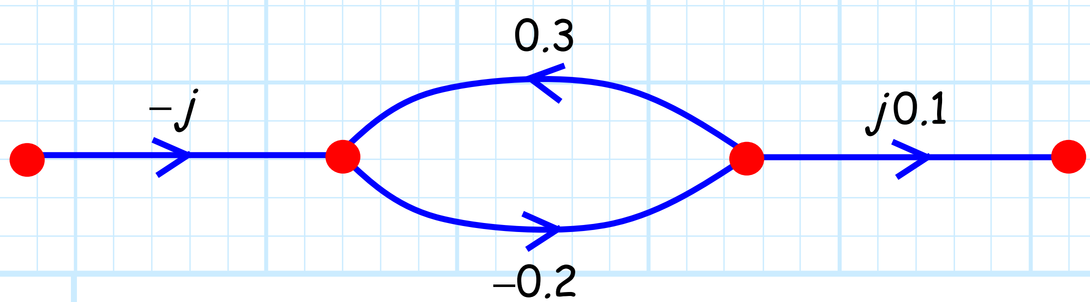
Note that this graph can be further simplified using **rule #1**.



Q: *Can we split the* ***other*** *branch of the loop? Is* ***this*** *signal flow graph:*



Likewise equivalent to this one ??:



A: **NO!!** Do not make this mistake! We **cannot** split the 0.3 branch because it terminates in a node with **two** incoming branches (i.e., $-j$ and 0.3). This is a **violation** of rule 4.

Moreover, the equations represented by the two signal flow graphs are **not** equivalent—they two graphs describe two **different** sets of equations!

It is important to remember that there is no "magic" behind signal flow graphs. They are simply a **graphical** method of representing—and then solving—a set of linear equations.

As such, the four basic **rules** of analyzing a signal flow graph represent basic **algebraic** operations. In fact, signal flow graphs can be applied to the analysis of **any** linear system, not just microwave networks.