Rules for Signal Flow Graph Decomposition

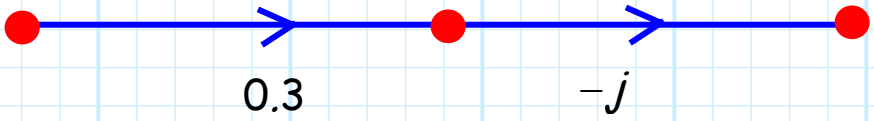
We can simplify (i.e., decompose) a signal flow graph, which can lead to direct solutions of microwave analysis problems.

There are four important rules that we can use to decompose a signal flow graph. As we apply these rules, we will eliminate both branches and nodes alike!

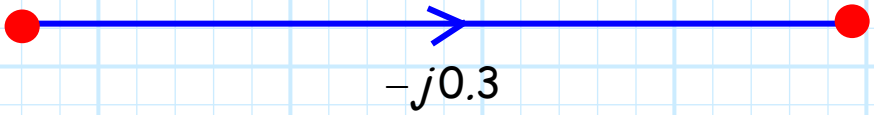
Rule 1 – *Series Rule*

If a node has one (and only one!) incoming branch, and one (and only one!) outgoing branch, the node can be eliminated and the two branches can be combined, with the new branch having a value equal to the product of the original two.

For example, the graph:



can be reduced to:



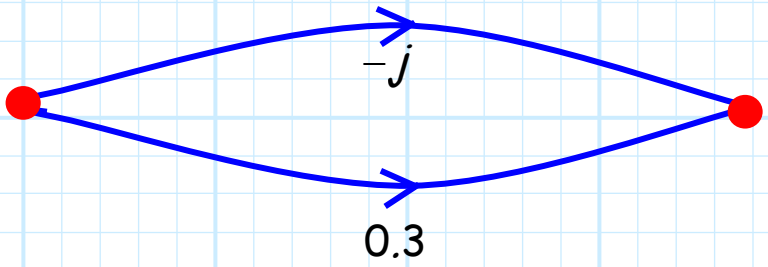
Note the center node is eliminated!

Warning! Make sure you do not eliminate a node in which you are interested!

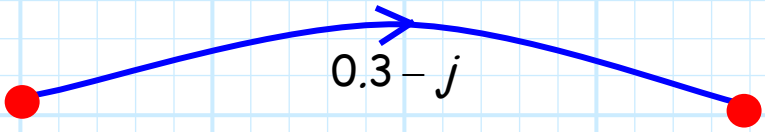
Rule 2 – *Parallel Rule*

If two nodes are connected by parallel branches—and the branches have the same direction—the branches can be combined into a single branch, with a value equal to the sum of each two original branches.

For example, the graph:

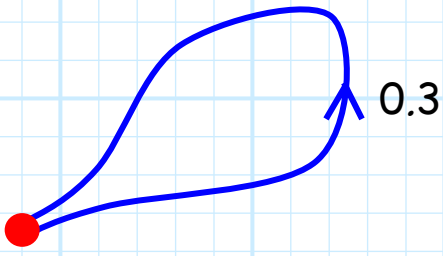


Can be reduced to:



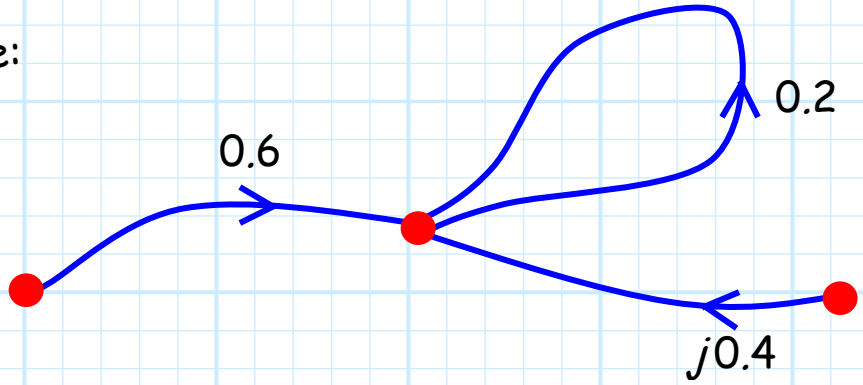
Rule 3 – *Self Loop Rule*

A self-loop is a branch that begins and ends at the **same** node!



We can eliminate a self-loop by multiplying **all** of the branches "**feeding**" the self-loop node by $1/(1-S_{sl})$, where S_{sl} is the value of the self loop branch.

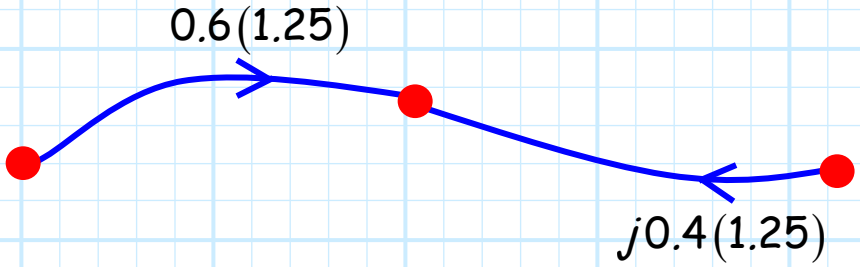
For example:



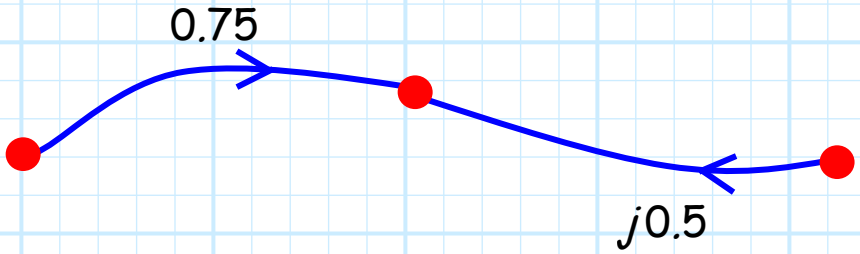
can be simplified by eliminating the self-loop. We multiply each of the two branches feeding the self-loop node by:

$$\frac{1}{1-S_{sl}} = \frac{1}{1-0.2} = 1.25$$

Therefore:



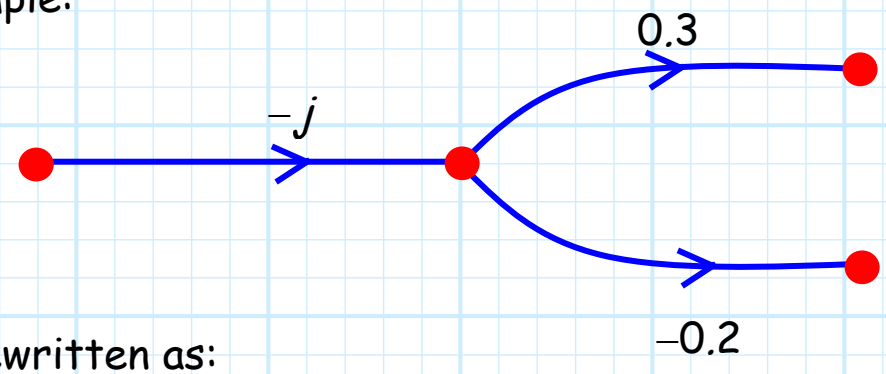
And thus:



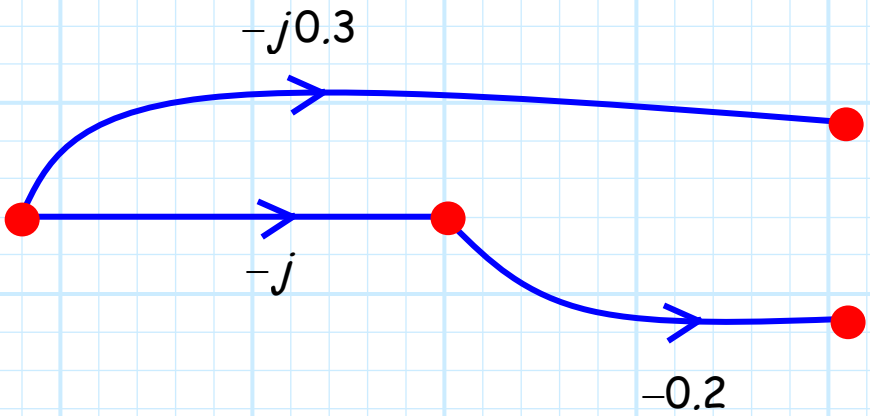
Rule 4 - *Splitting Rule*

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

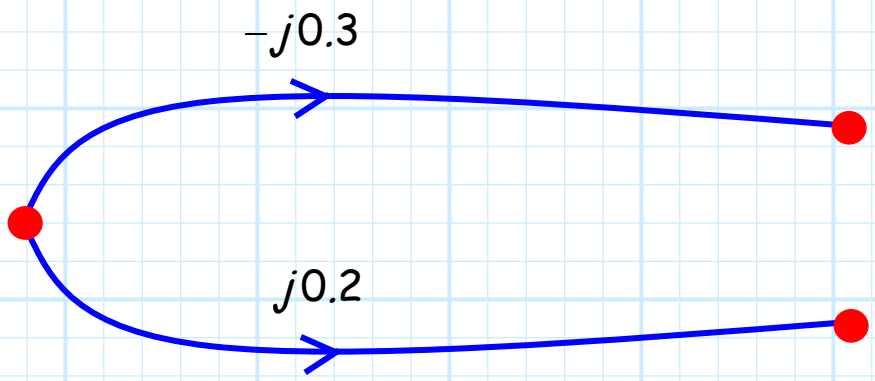
For example:



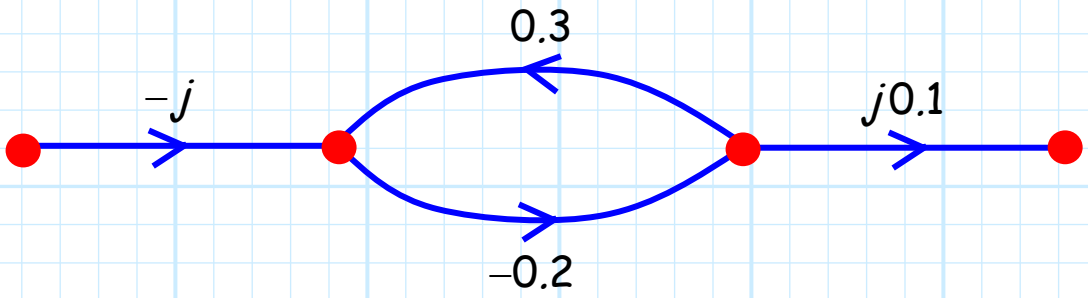
can be rewritten as:



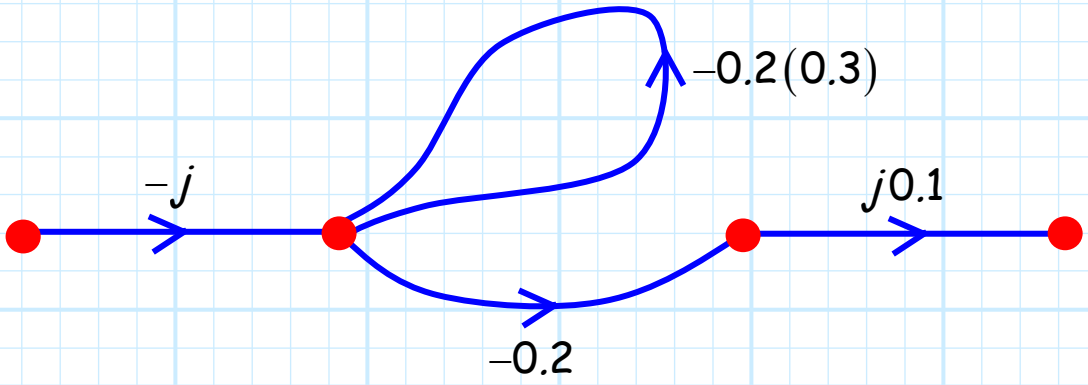
Of course, from rule 1, this graph can be further simplified as:



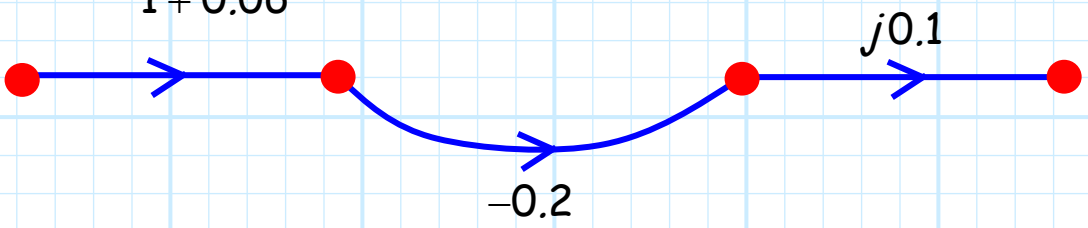
The splitting rule is particularly useful when we encounter signal flow graphs of the kind:



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: $\dfrac{-j}{1+0.06}$



Of course this graph can be further simplified with rule 1: