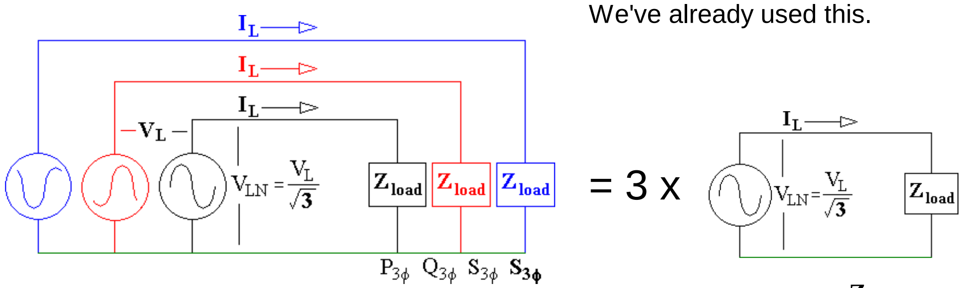
A. Stolp
9/20/20

Full 3-phase diagrams can be very cumbersome. In a balanced system you only need to consider one phase

Per-phase Analysis

Balanced 3-phase systems can be represented by just one phase.
We've already used this.



$$P_{1\phi} = \frac{P_{3\phi}}{3} \qquad Q_{1\phi} = \frac{Q_{3\phi}}{3}$$

$$\mathbf{S}_{1\phi} = \frac{\mathbf{S}_{3\phi}}{3}$$

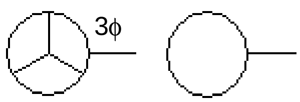
$$S_{1\phi} = |\mathbf{S}_{1\phi}| = \frac{S_{3\phi}}{3}$$

Anything not Y-connected can be converted to a Y- equivalent. $\mathbf{Z}_Y = \frac{\mathbf{Z}_\Delta}{3}$

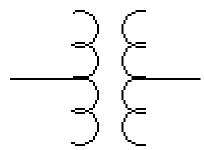
One-Line Diagrams

In a balanced system neutral current is zero, so in one-line diagrams, even the neutral connections are omitted.

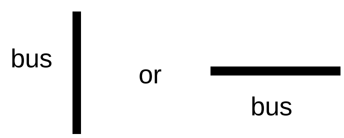
Some Important symbols



generator or motor

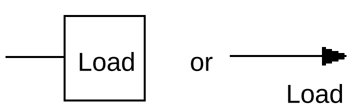


transformer



All items connected to one bus have same voltage. Like a circuit node, but actually represents 4 connections.

transmission line



typ: oil or SF_6

powered general

Circuit breakers

manual powered

Switches

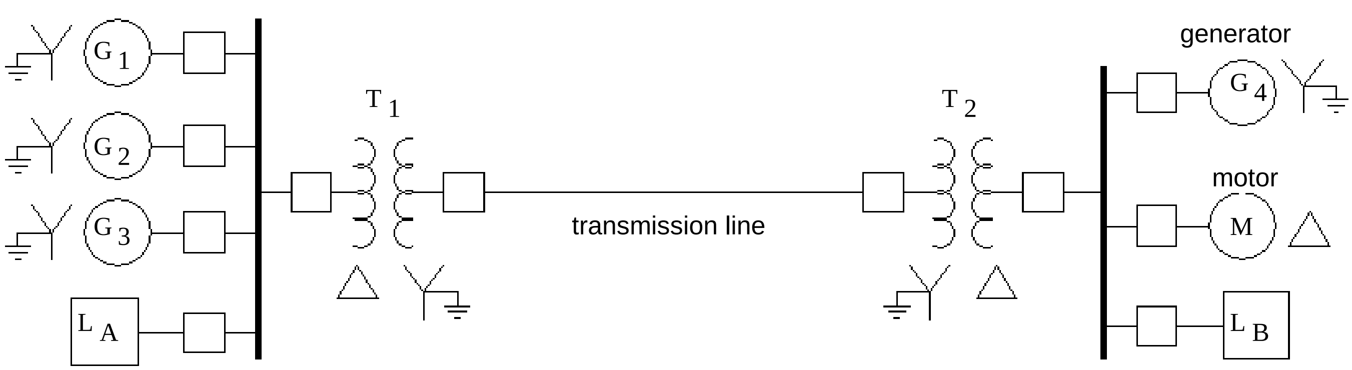
Connection symbols:

delta wye wye with ground

Can also include resistors, inductors, capacitors and impedances
Unfortunately these symbols are not as well standardized as you would think

Example

3 generators



load A Station A Station B load B

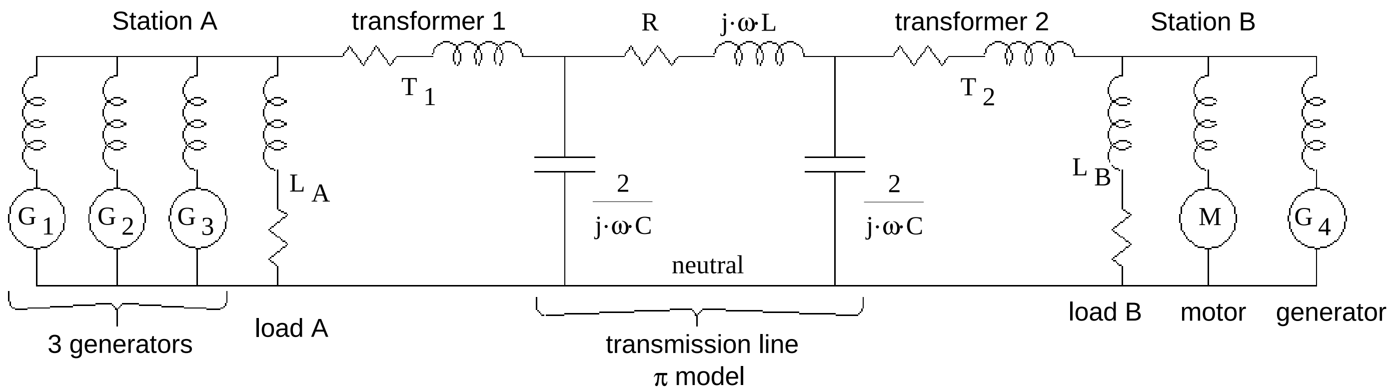
Many more real examples:
www.ece.utah.edu/~ece3600/SingleLineML102530301.pdf start p.13

Impedance Diagrams

Same system

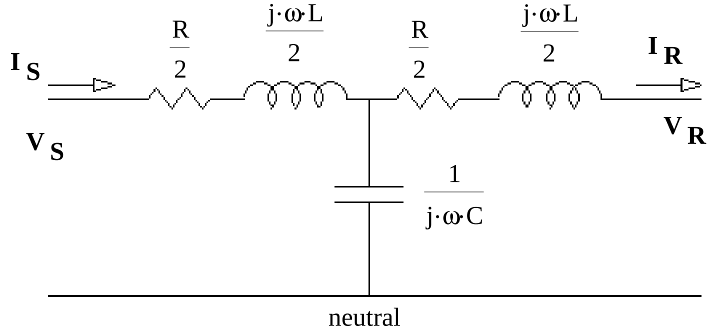
Component values are per-unit (pu).

If you didn't use pu values then you would have to transform impedances across the transformers.



A T model of the transmission line may be easier to work with

T model:

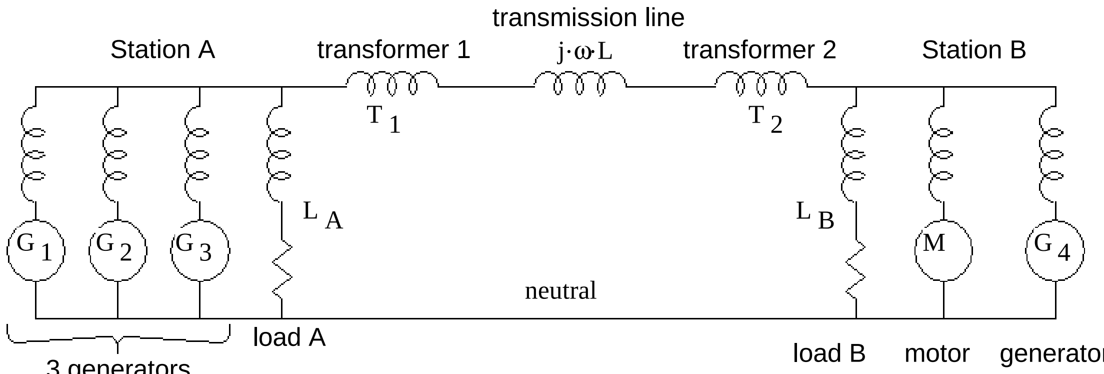


Reactance Diagrams

Same system

Ignore the line capacitances, and all resistors but those in the loads

Component values are per-unit (pu).



Loads are often Omitted

One-Line Impedance Diagrams

Component values are per-unit (pu).