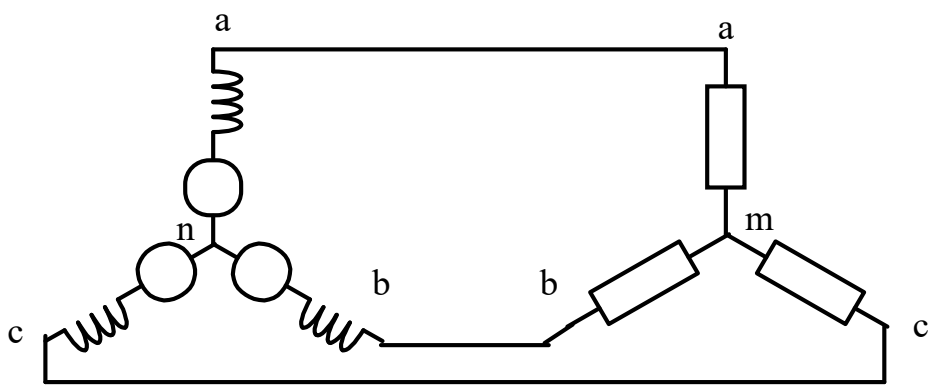
ECE 523: Symmetrical Components Examples

If a load is unbalanced, its neutral, m, will not be at the same potential as the source neutral, n. Derive the between the neutral shift V_{mn} and the zero sequence voltage. V_{am0} for the system shown below. Similar 2.11. Hint, consider the line to ground voltages, line to neutral voltages and neutral to ground voltages.



$V_{m\_n} = V_{m\_ground} - V_{n\_ground}$

$V_{an} = V_{a\_ground} - V_{n\_ground}$

and $V_{am} = V_{a\_ground} - V_{m\_ground}$

so, substituting $V_{m\_n} = V_{m\_ground} - V_{n\_ground} = \left(V_{a\_ground} - V_{am}\right) - \left(\left(V_{a\_ground} -\right.\right.$

Then rearranging terms:

$$V_{m\_n} = V_{an} - V_{am}$$

similarly $V_{m\_n} = V_{bn} - V_{bm}$

$$V_{m\_n} = V_{cn} - V_{cm}$$

- Adding these three expressions, results in: $3V_{m\_n} = \left(V_{an} + V_{bn} + V_{cn}\right) - \left(V_{am} + V_{bm} + V_{cm}\right)$

- Applying the Symmetrical Components transformation:

$$3V_{an0} = \left(V_{an} + V_{bn} + V_{cn}\right) = 0$$

Since the source is still balanced

Similarly

$$3V_{am0} = \left(V_{am} + V_{bm} + V_{cm}\right)$$

This does not sum to 0, since the load is unbalanced

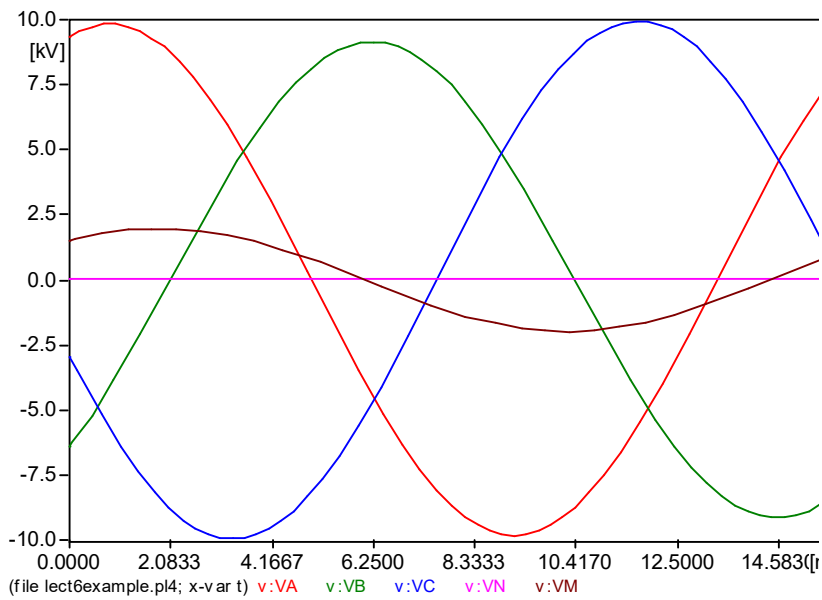
Therefore

$$3V_{m\_n} = 3V_{an0} - 3V_{am0} = -3V_{am0}$$

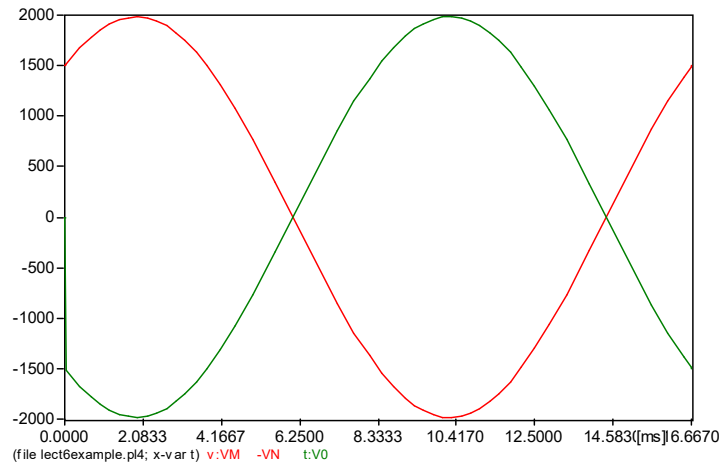
$$\boxed{V_{m\_n} = -V_{am0}}$$

As a check, the circuit was simulated with ATPDraw, which was also used to determine the symmetrical instantaneous quantities.

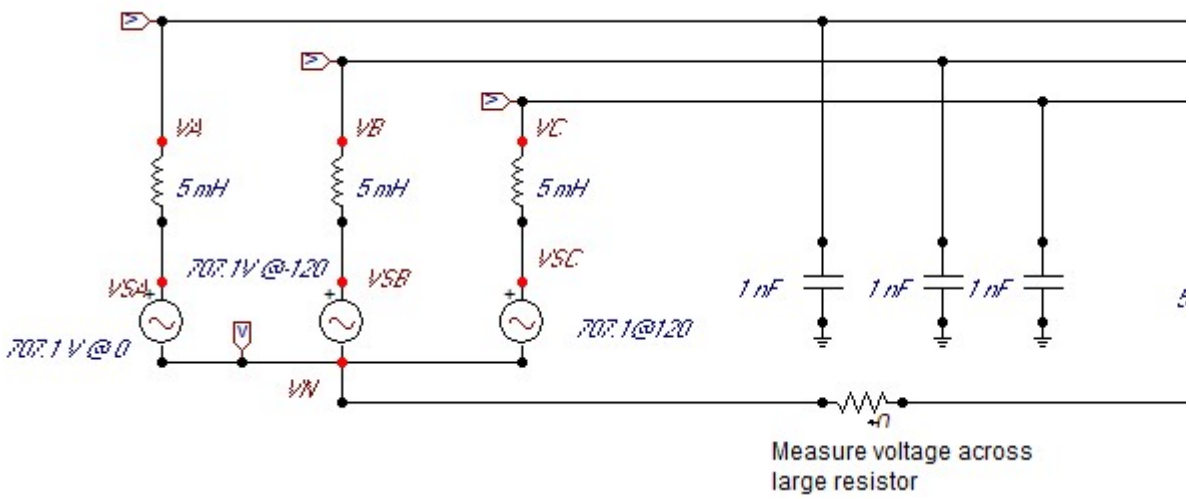
- First we see Vag, Vbg, Vcg, Vng and Vmg (brown line)
- Note the unbalance in the line-to-ground voltages.



- Next plot instantaneous values of Vmn and V0 (note that V0 is simply 1/3*(Vam + Vbm + Vcm). No degree phase difference.



ATPDraw Schematic



- The capacitors were added to provide a ground reference. The capacive reactances are quite large and results otherwise.
- Control modelling language TACS used to calculate V0