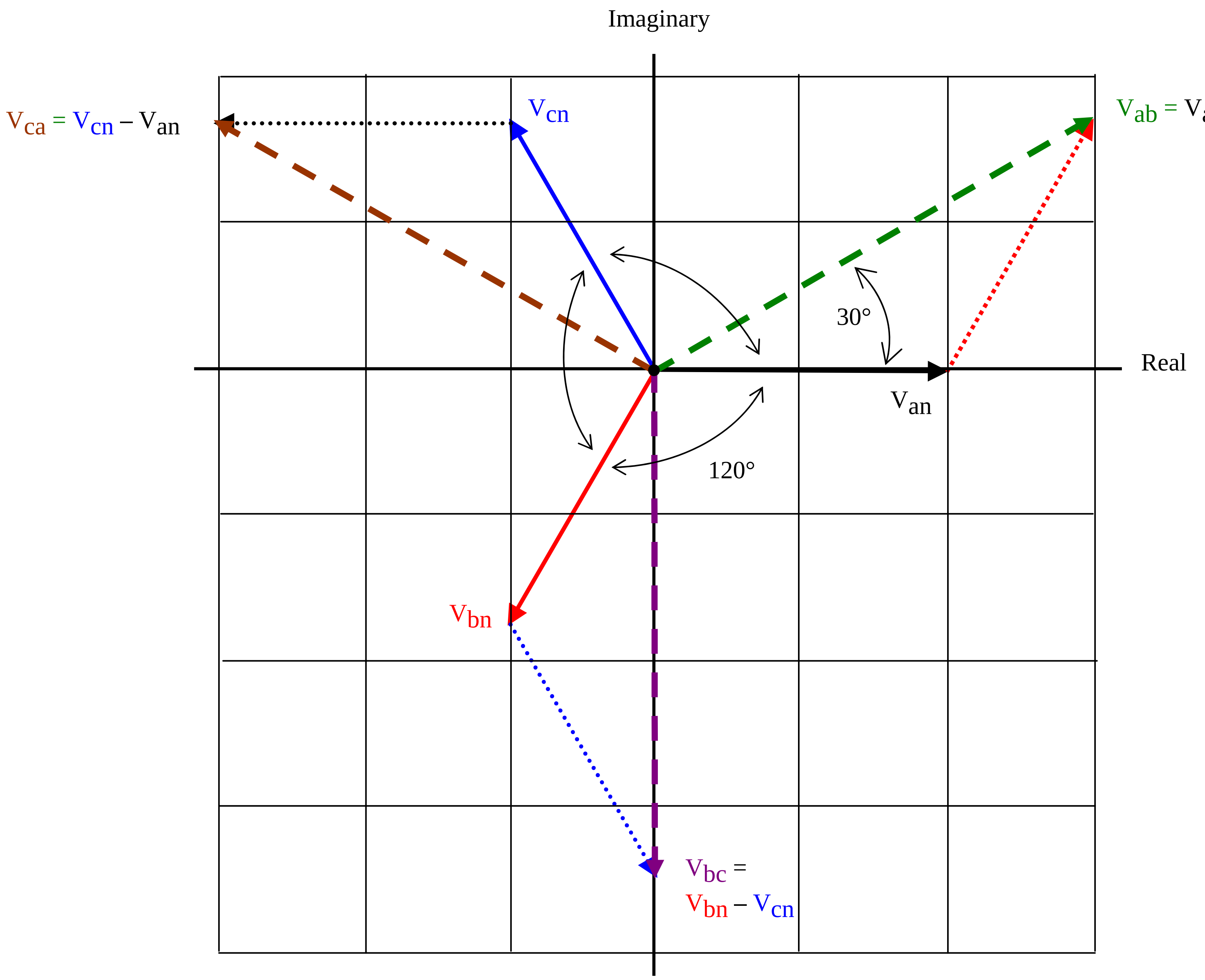
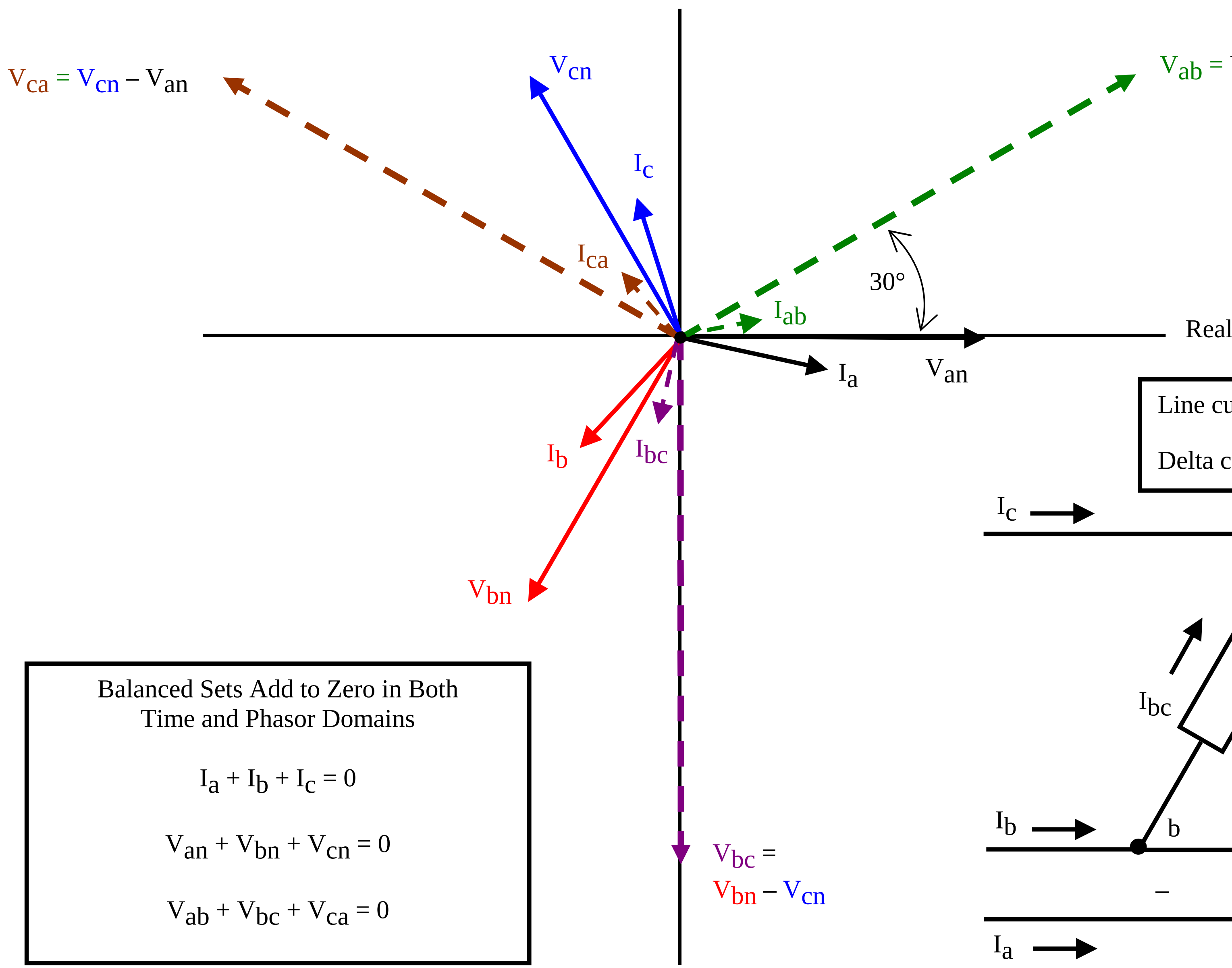


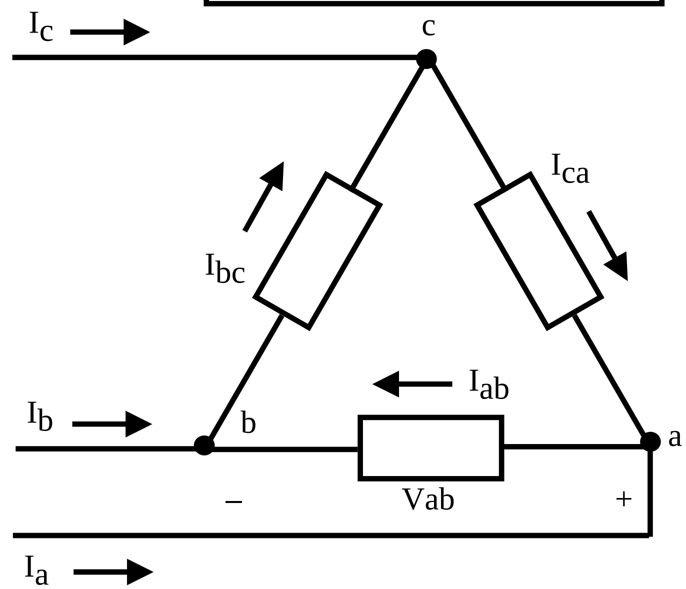
The phasors are rotating counter-clockwise.

The magnitude of line-to-line voltage phasors is $\sqrt{3}$ times the magnitude of line-to-neutral voltage phasors.



Line currents I_a, I_b, and I_c

Delta currents I_{ab}, I_{bc}, and I_{ca}



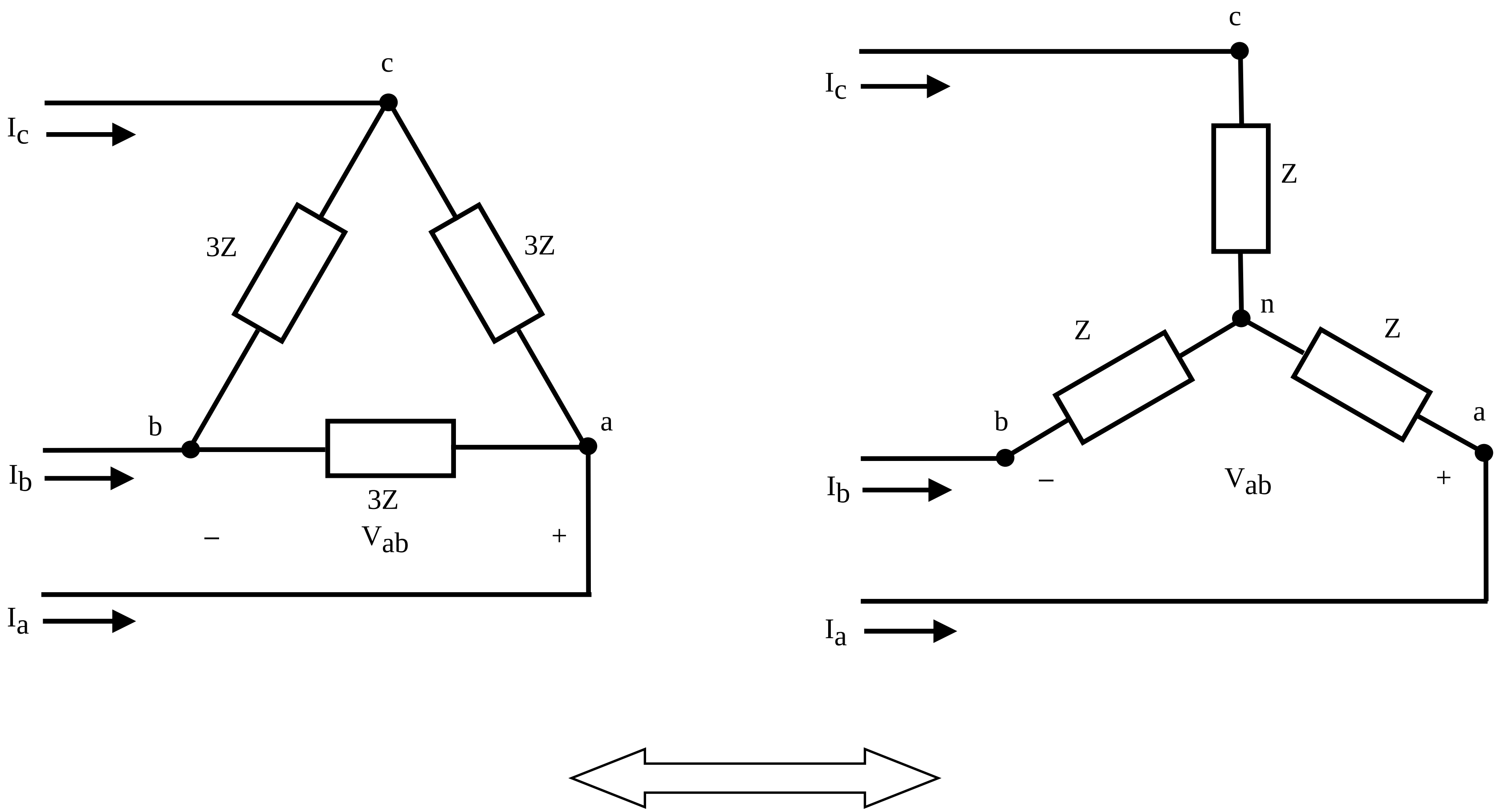
Balanced Sets Add to Zero in Both
Time and Phasor Domains

$$I_a + I_b + I_c = 0$$

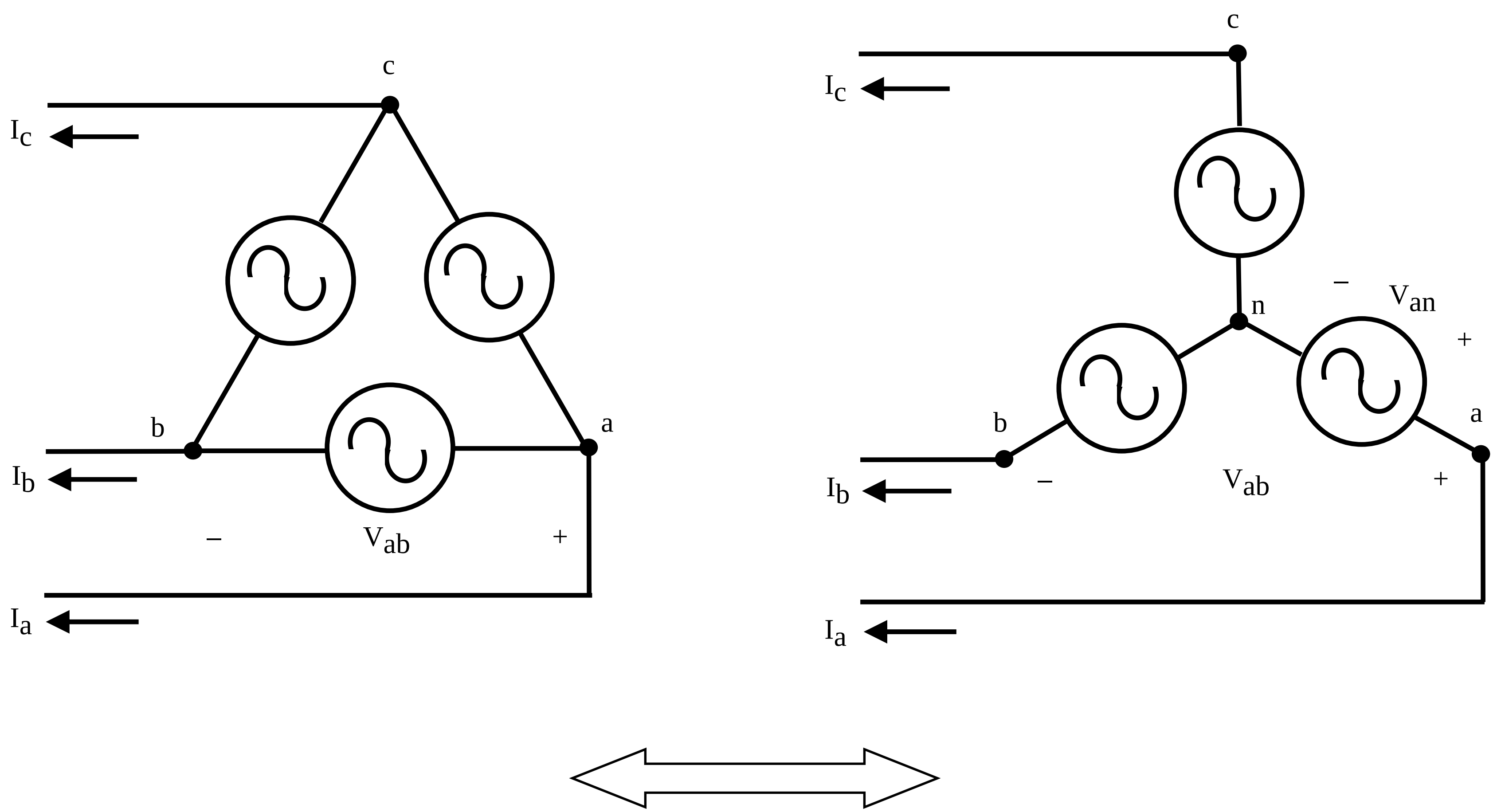
$$V_{an} + V_{bn} + V_{cn} = 0$$

$$V_{ab} + V_{bc} + V_{ca} = 0$$

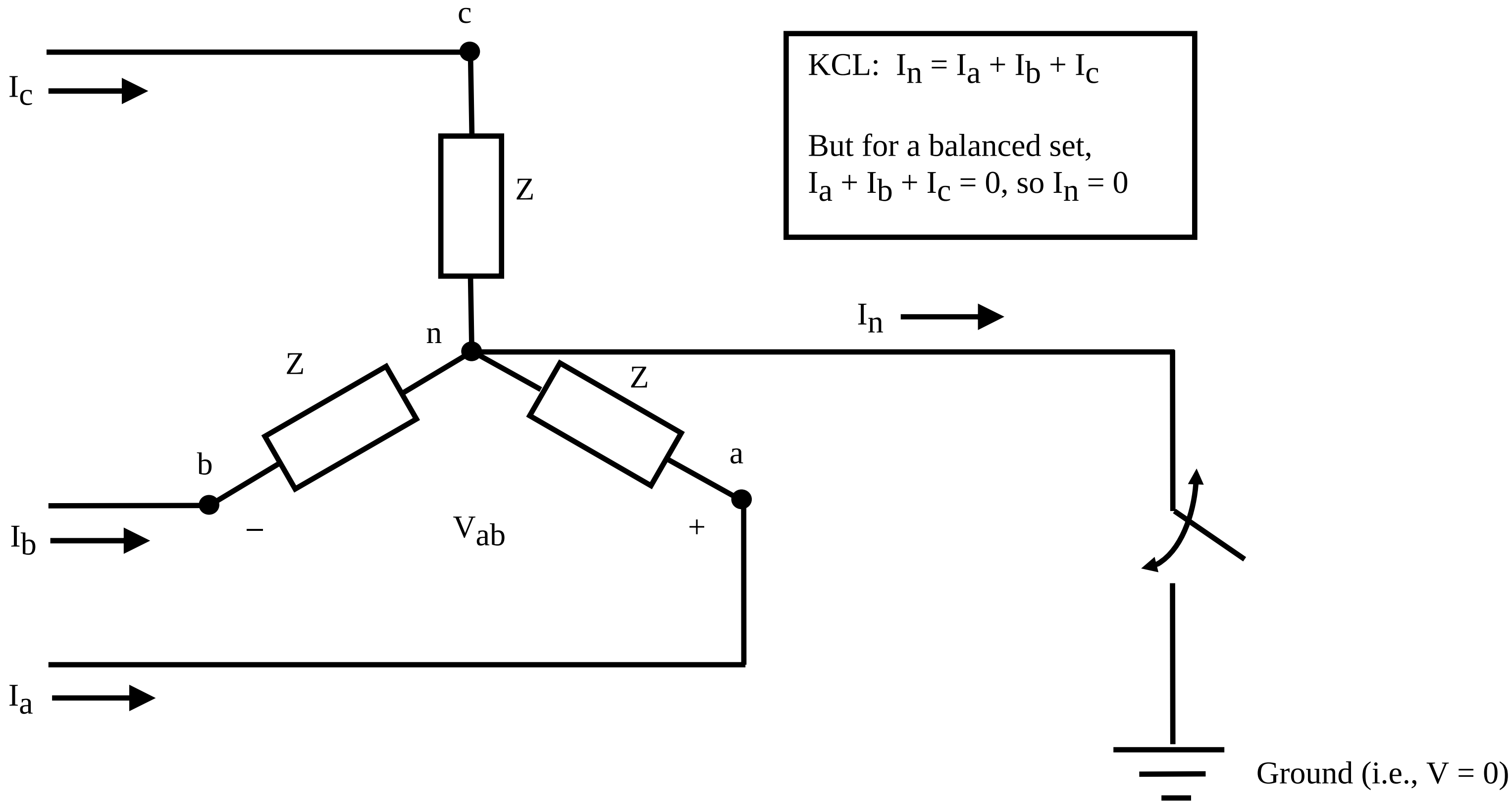
Conservation of power requires that the magnitudes of delta currents I_{ab}, I_{ca}, and I_{bc} are $\frac{1}{\sqrt{3}}$ times the magnitude of line currents I_a, I_b, I_c.



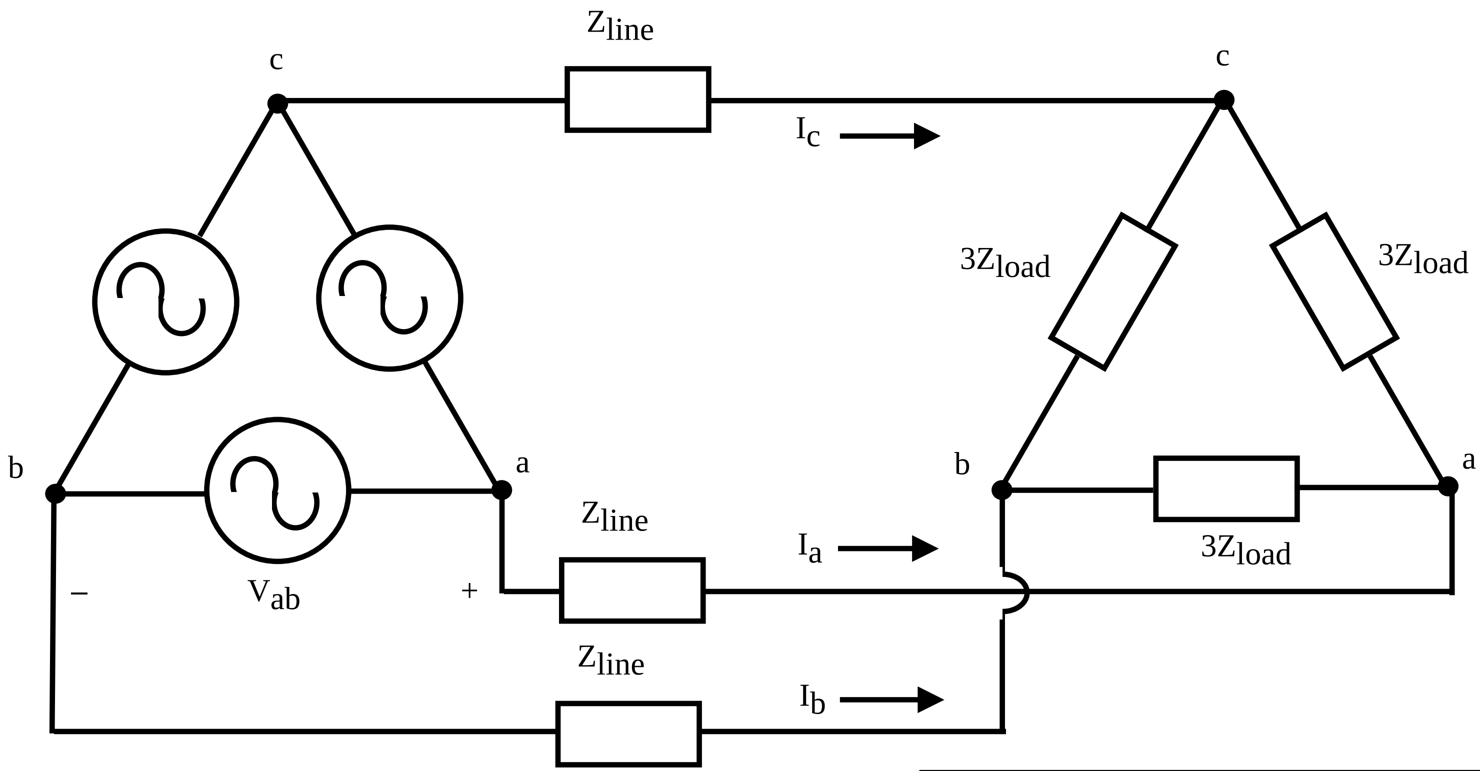
The Two Above Loads are Equivalent in Balanced Systems
(i.e., same line currents I_a, I_b, I_c and phase-to-phase voltages V_{ab}, V_{bc}, V_{ca} in both cases)

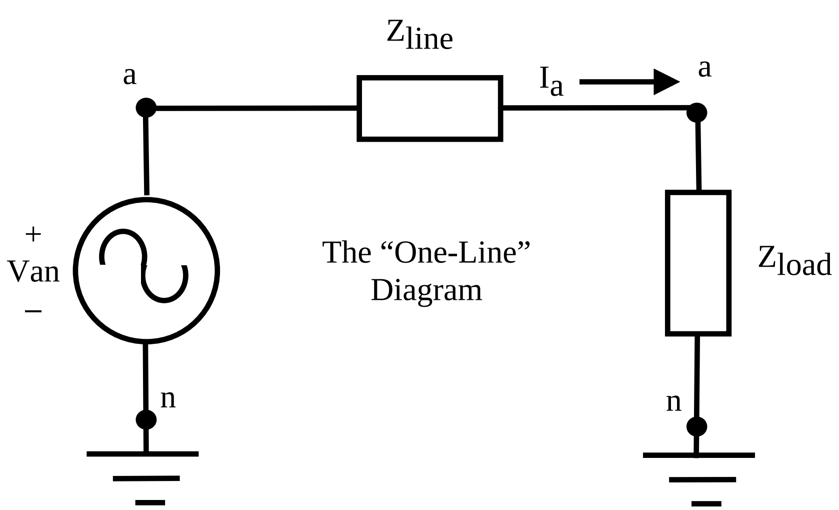


The Two Above Sources are Equivalent in Balanced Systems
(i.e., same line currents I_a, I_b, I_c and phase-to-phase voltages V_{ab}, V_{bc}, V_{ca} in both cases)



The Experiment: Opening and closing the switch has no effect because I_n is already zero for a three-phase balanced set. Since no current flows, even if there is a resistance in the grounding path, we must conclude that $V_n = 0$ at the neutral point (or equivalent neutral point) of any balanced three phase load or source in a balanced system. This allows us to draw a "one-line" diagram (typically for phase a) and solve a single-phase problem. Solutions for phases b and c follow from the phase shifts that must exist.





Balanced three-phase systems, no matter if they are delta connected, wye connected, or a mix, are easy to solve if you follow these steps:

1. Convert the entire circuit to an equivalent wye with a grounded neutral.
2. Draw the one-line diagram for phase a, recognizing that phase a has one third of the P and Q.
3. Solve the one-line diagram for line-to-neutral voltages and line currents.
4. If needed, compute line-to-neutral voltages and line currents for phases b and c using the ±120° relationships.
5. If needed, compute line-to-line voltages and delta currents using the $\sqrt{3}$ and ±30° relationships.