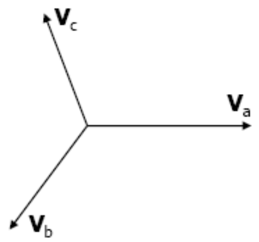
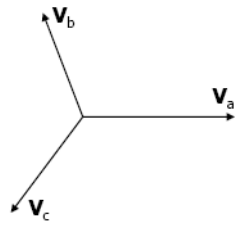
abc (positive) phase sequence: b-phase lags a-phase by 120^0, and c-phase leads a-phase by 120^0.



$$\mathbf{V}_a = V_m \angle 0^0$$
$$\mathbf{V}_b = V_m \angle -120^0$$
$$\mathbf{V}_c = V_m \angle +120^0$$

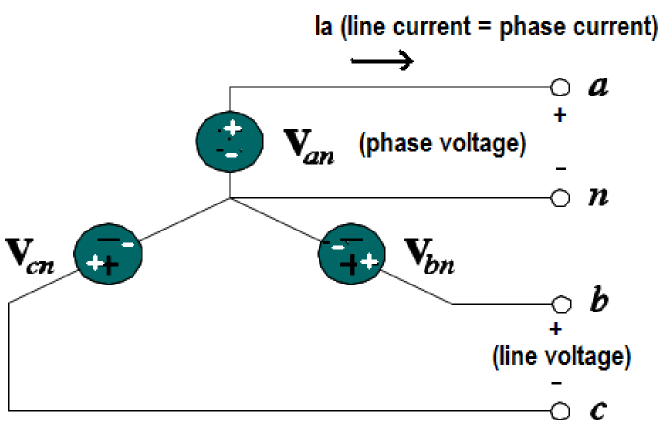
acb (negative) phase sequence:



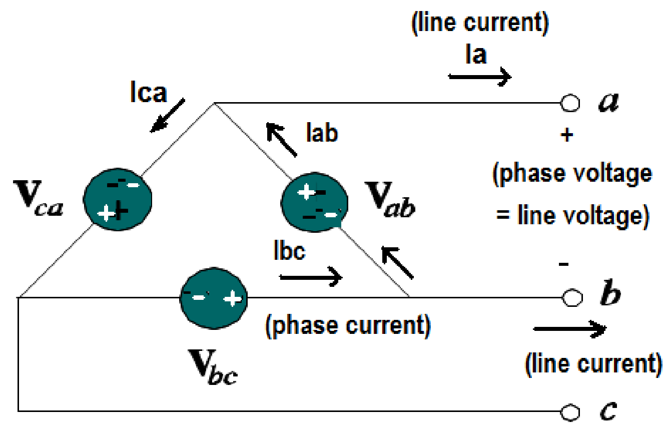
$$\mathbf{V}_a = V_m \angle 0^0$$
$$\mathbf{V}_b = V_m \angle +120^0$$
$$\mathbf{V}_c = V_m \angle -120^0$$

Two Different Three-phase Source configurations:

Wye (or Y) Connected Source



Delta (or Δ) Connected Source



<table>
<tr>
<td>Wye Source (for Load just reverse all currents):

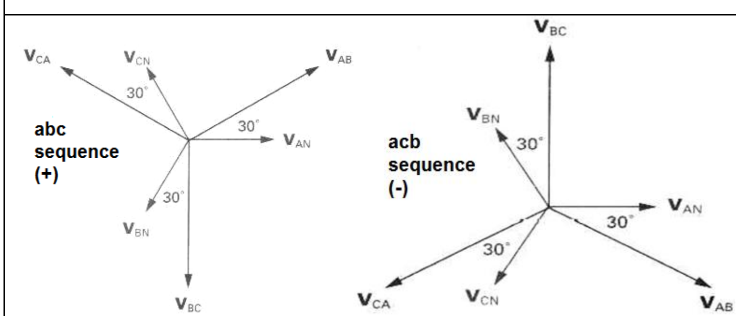
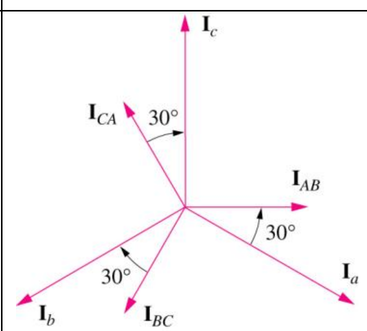
Phase Voltages Van, Vbn, Vcn
Line Voltages Vab, Vbc, Vca

(KVL:) Vab = Van –Vbn = $\sqrt{3}$ Van$\underline{/+30}$ (abc)
=$\sqrt{3}$ Van$\underline{/-30}$ (acb)

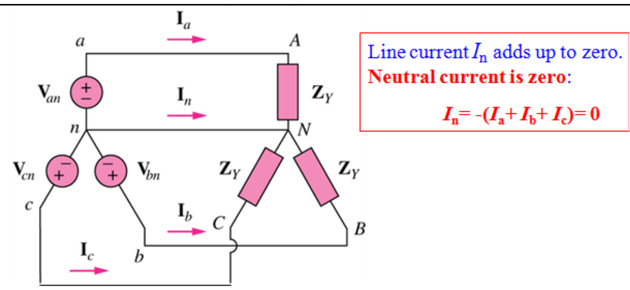
Phase Currents and Line Currents are the same
Ia, Ib, Ic are phase and line currents</td>
<td>Delta Source (for Load just reverse all currents):

Phase Voltages and Line Voltages are the same
Vab, Vbc, Vca are phase and line voltages

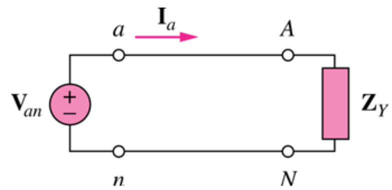
Phase Currents Iab, Ibc, Ica
Line Currents Ia, Ib, Ic

(KCL:) Ia = Iab – Ica = $\sqrt{3}$ Iab$\underline{/-30}$ (abc)
= $\sqrt{3}$ Iab$\underline{/+30}$ (acb)</td>
</tr>
<tr>
<td>
Wye Voltages (abc) (acb)</td>
<td>
Delta Currents – (abc) (acb)</td>
</tr>
</table>

Balanced Y-Y Connection:

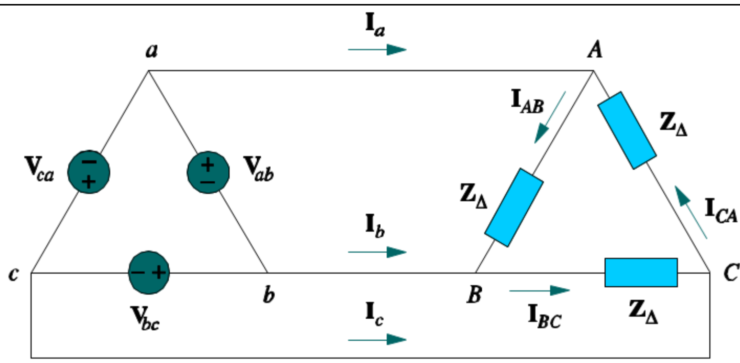


Single Phase Equivalent



Ia = Van / Zy   and all other Voltages and Currents found by using phase relationships above

Balanced Delta – Delta Connection



Iab = Vab / Z_Δ

Ibc = Vbc / Z_Δ

Ica = Vca / Z_Δ

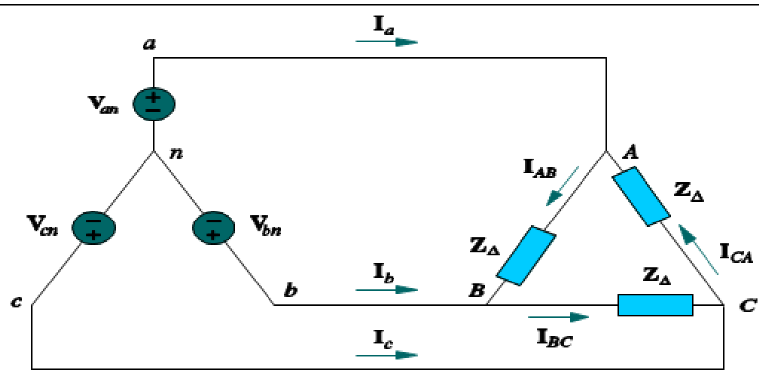
(abc)

Ia = Iab – Ica = $\sqrt{3}$ Iab$\underline{/-30}$ (+30 acb)

Ib = Ibc – Iab = $\sqrt{3}$ Ibc$\underline{/-30}$

Ic = Ica – Ibc = $\sqrt{3}$ Ica$\underline{/-30}$

Balanced Wye – Delta Connection



Iab = Vab / Z_Δ

Ibc = Vbc / Z_Δ

Ica = Vca / Z_Δ

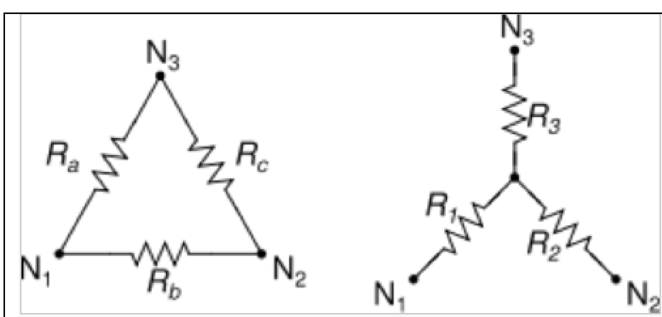
(abc)

Ia = Iab – Ica = $\sqrt{3}$ Iab$\underline{/-30}$ (+30 acb)

Ib = Ibc – Iab = $\sqrt{3}$ Ibc$\underline{/-30}$

Ic = Ica – Ibc = $\sqrt{3}$ Ica$\underline{/-30}$

Delta-Wye Conversions: using R below but Z works the same way:



$$R_1 = \frac{R_a R_b}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$R_1 = \frac{R_b R_a}{R_T}$$

$$R_2 = \frac{R_b R_c}{R_T}$$

$$R_3 = \frac{R_a R_c}{R_T}$$

where $R_T = R_a + R_b + R_c$

BALANCED: IF R1 = R2 = R3 = RY and Ra=Rb=Rc = RΔ, then RΔ = 3RY, and RY = RΔ/3