EECE 370 Handout 2

Three-Phase Circuits – Appendix A

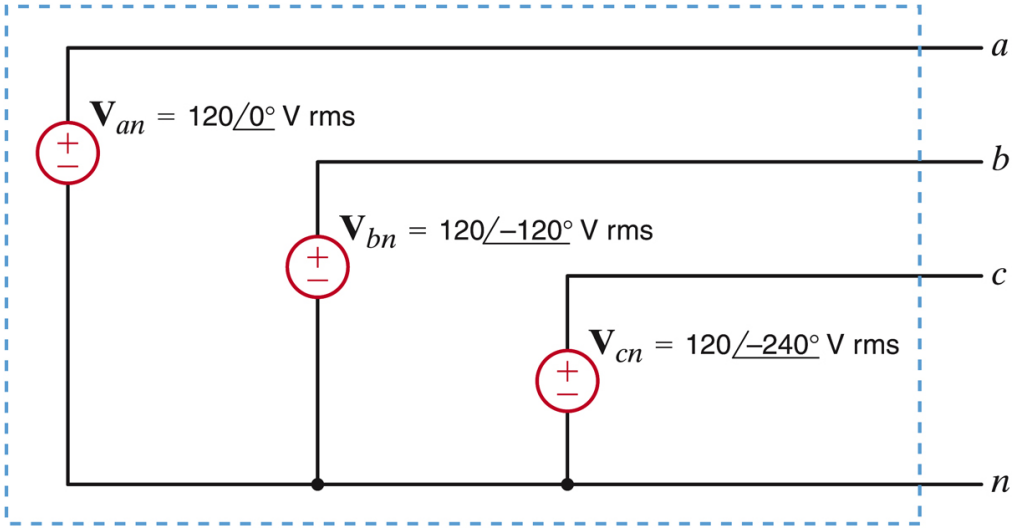
What are the advantages that *three-phase* ac power systems have over *single-phase* ac power systems?

1. More power per kilogram.

2. Instantaneous power is constant.

3. Induction motors start without special auxiliary starting windings.

Three-phase circuits are those in which the forcing function is a three-phase system of voltages



What are the conditions for a three-phase system of voltages to be *balanced*?

1-

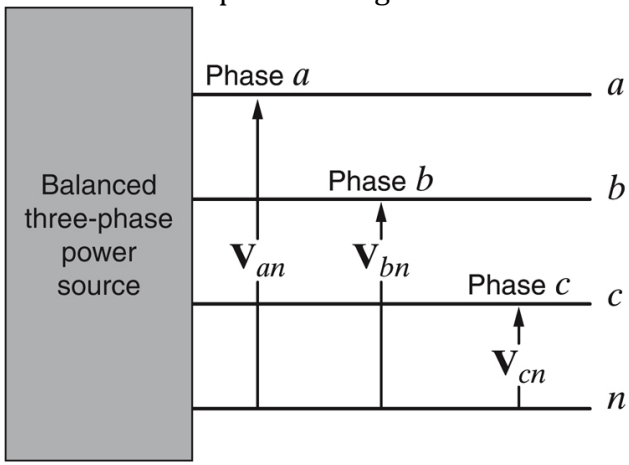
2-

If the loads are such that the currents produced by the voltages are also balanced, the entire circuit is referred to as a balanced.

Example:
Find the expression of the instantaneous power in a three-phase circuit.

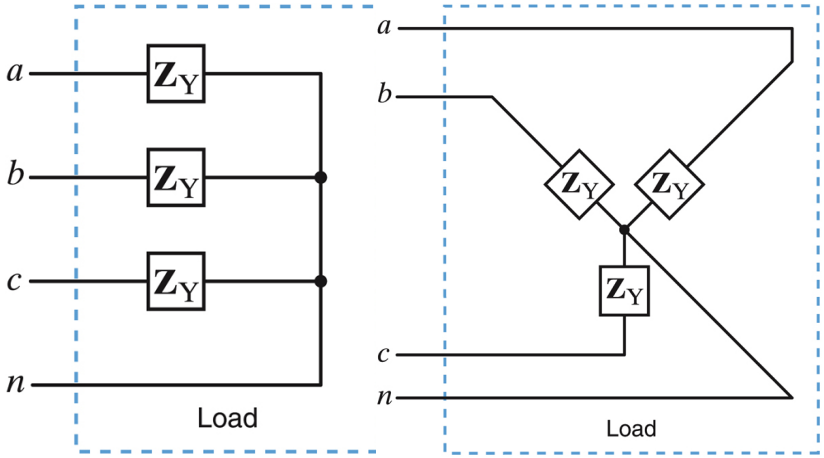
Three-Phase Connections

Balanced three-phase voltage source

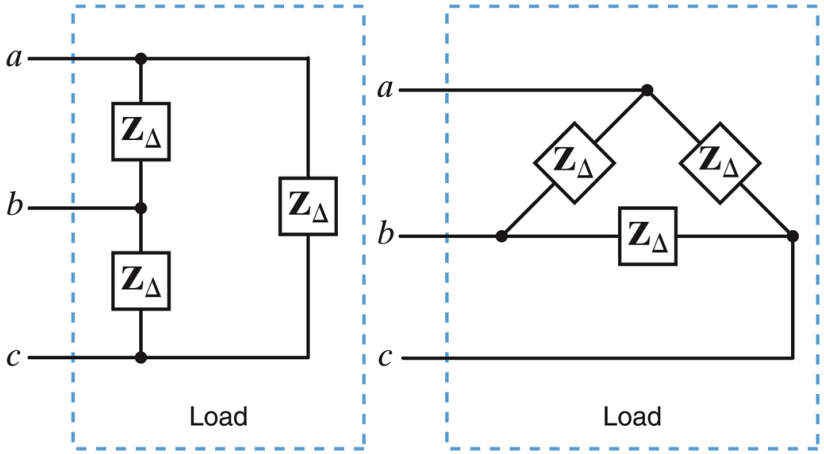


Line-to-neutral voltages

Y-connected loads

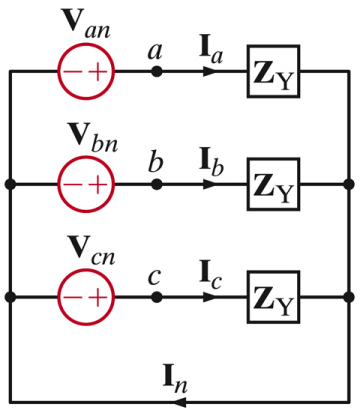


Δ-connected loads



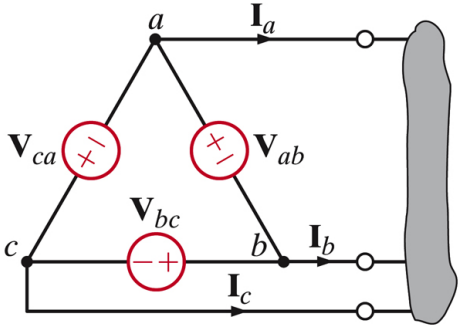
Source/Load Connections

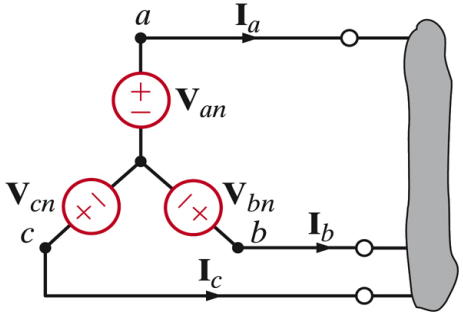
**Balanced Y-Y Connection*



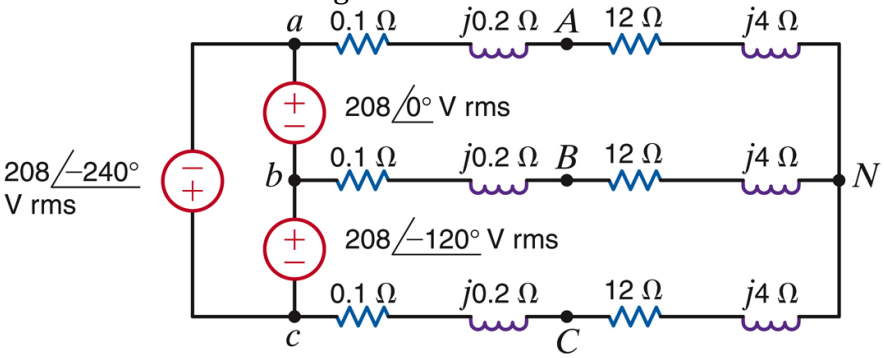
Example:
Positive sequence, balanced Y-Y three-phase circuit.
Source $V_\phi = 120$ Vrms. $\hat{Z}_{line} = 1 + j1\ \Omega$. $\hat{Z}_Y = 20 + j10\ \Omega$.
Determine the line currents.
Determine the phase voltages at the load.
Determine the line voltages at the load.

Δ-connected Source

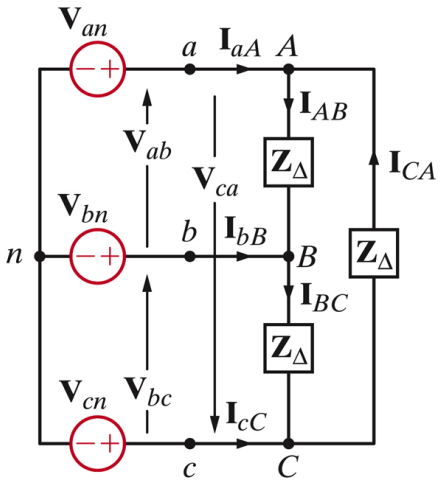




Example:
Determine the line voltages at the load.



*Δ-connected Load



Example:
A delta-connected load consists of 10 Ω resistance in series with 20 mH inductance. The source is Y-connected, abc sequence, 60 Hz, $\tilde{V}_{an} = 120\angle 30^\circ$ Vrms. Determine the line currents and the phase currents in the Δ-connected load.

Power Relationships

Per-phase real power:

Per-phase reactive power:

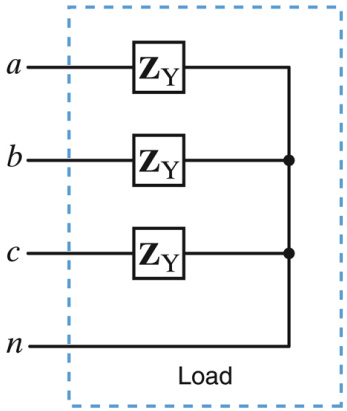
In terms of phase/line quantities

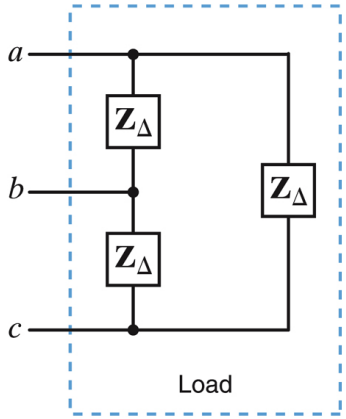
Total (three-phase) real power:

Total (three-phase) reactive power:

Total (three-phase) complex power:

Total (three-phase) apparent power:

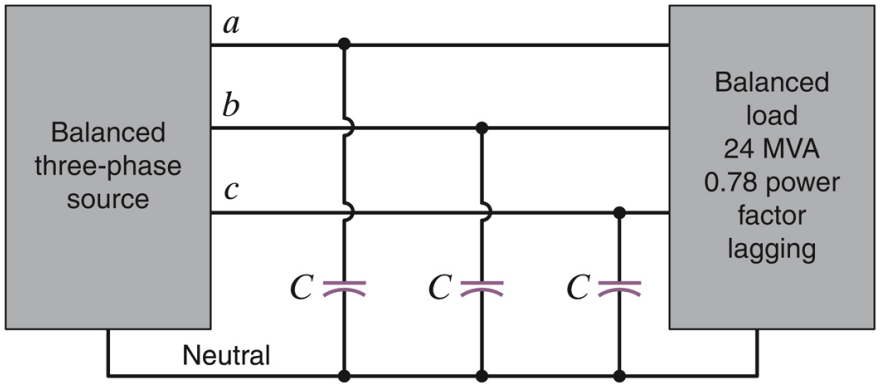




Example:
A three-phase balanced wye-delta system has a line voltage magnitude of 208 Vrms. The line impedance is negligible. The total real power absorbed by the load is 1200 W and the power factor angle of the load is 20°. Determine the magnitude of the line current and the value of the load impedance per phase in the delta.

Example:
The following balanced three-phase loads are served by a balanced three-phase source:
Load 1: 24 kW at PF = 0.6 lagging
Load 2: 10 kW at PF = 1
Load 3: 12 kVA at PF = 0.8 leading
The magnitude of the line voltage at the load is 208 Vrms, and the line impedance is $0.05 + j0.02\ \Omega$.
a) Determine the magnitude of the line current and the combined power factor at the load.
b) Determine the magnitude of the line voltage and the power factor at the source.

Power Factor Correction



Example: in the previous diagram, $f = 60$ Hz, $V_L = 34.5$ kVrms, required PF = 0.9 lagging. Find C.