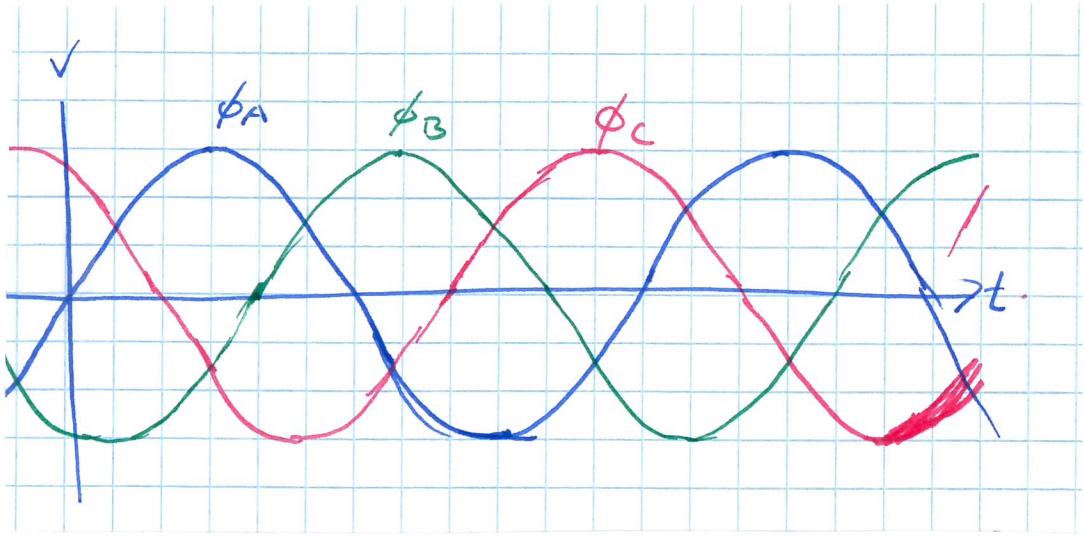
3 Phase Power

Benefits:

- more efficient power distribution (vs 1 phase)
- cleaner conversion between AC, DC
- Simple powerful motor operation.

The Idea: (ϕ_A, ϕ_B, ϕ_C)

3 related voltages, all with the same amplitude with phases 120° apart from each other



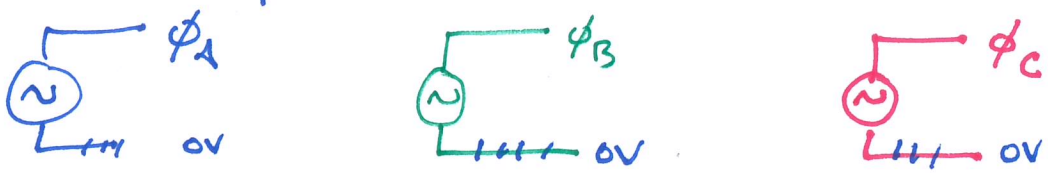
These voltages have the special trait that they add to 0V.

$$\phi_A + \phi_B + \phi_C = 0V \quad \text{at every point in time.}$$

As a result they carry with them (as a whole) implicity the neutral voltge V = 0V.

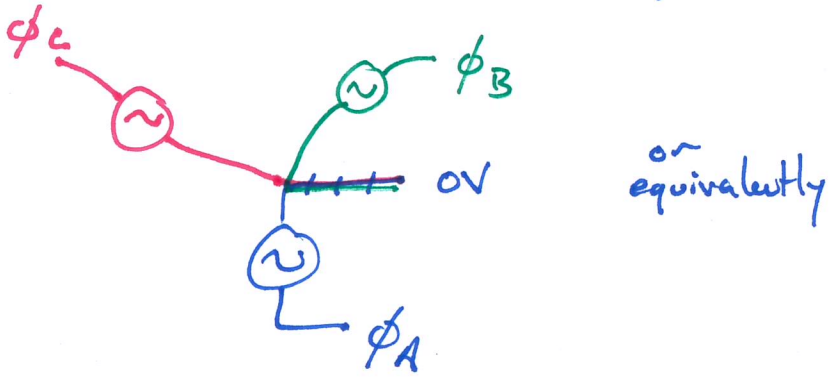
There are 3 ways of fitting this power on to wires

① three independent circuits

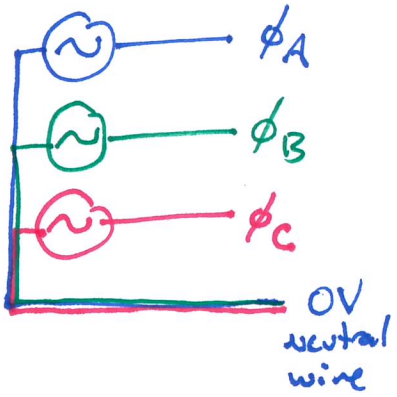


each circuit operates independently. Note that the neutral wire for each circuit is at the same voltage so the return current can easily flow on one common wire. Total wires required: 6

② three phase WYE configuration

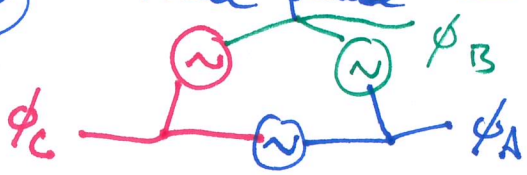


or equivalently



In many situations the returning current for ϕ_A prefers to run on ϕ_B's ϕ_C so little current flows on the neutral wire. In fact when the loads that ϕ_A, ϕ_B, and ϕ_C are balanced (definition will follow later) no current flows on the neutral wire. Total wires required: 4

③ three phase Δ configuration



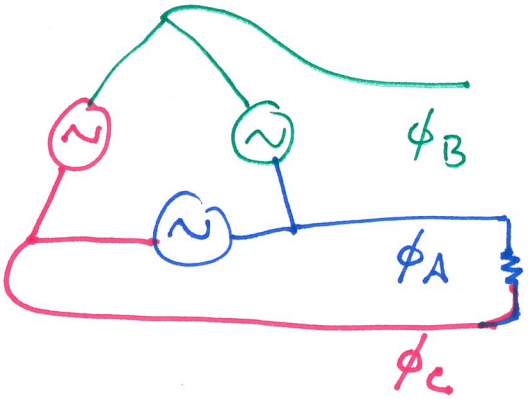
Total wires required: 3
Ideal for power distribution

Connecting loads to 3 phase power

A load (e.g. a resistor) can be powered from 3 phase power. How this is done depends on the topology (WYE vs Δ).

3 phase Δ:

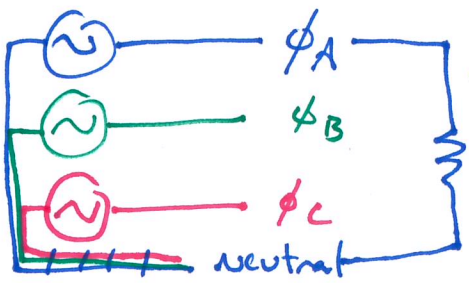
there is only 1 way to connect the load, between phases.



here the resistor is connected to ϕ_A & ϕ_C w/ the voltge $\phi_A - \phi_C$ across it. this is the voltge provided by the Blue power source.
Connecting to ϕ_A & ϕ_B or ϕ_B & ϕ_C yields the same amplitude for the voltage.

3 phase WYE:

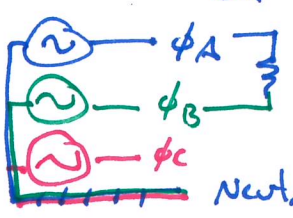
the same load can be connected in 2 ways w/ the WYE topology.



Phase to Neutral

Voltge across load $= \phi_A - 0 = \phi_A$

OR



Phase to phase

voltge across load $= \phi_A - \phi_B$

$(\phi_A - \phi_B)_{Rms} = \sqrt{3}\,\phi_{A\,Rms}$ => Higher Voltge