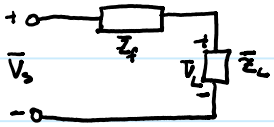
2018-09-05-1

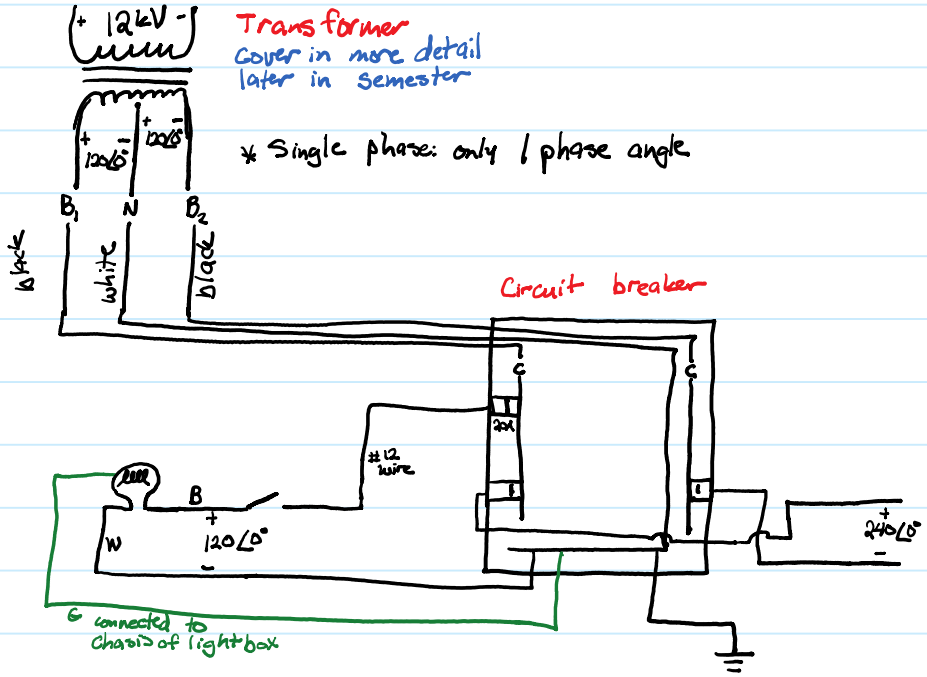
Note: Feeder system: wires have impedences



Last time:

1) Power triangle
2) Computing power
3) Conservation of complex power and power factor correction

Today: 1) Residential single phase (1ϕ) power
2) Approximating 2ϕ power
3) Intro to 3ϕ power



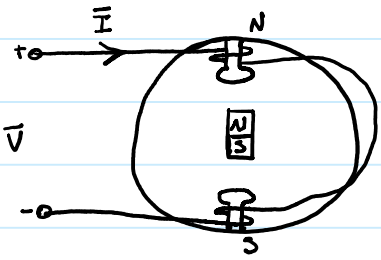
Stove, Dryer, electric car charger, Furnace, Hot water heater, etc.

120/240
1ϕ 3wire

* 1ϕ has problems with motors:

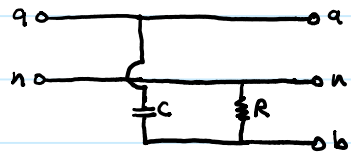
a) pulsating power
b) no starting torque

- Repulsive and attractive forces act through center, giving no torque.
- However, if something started rotation, it would continue.



* This problem can be fixed by adding a second phase. How?

Circuit to motor:



$$\bar{I}_b = \frac{\bar{V}_{an}}{R - j\frac{1}{\omega C}} \qquad \bar{V}_b = R\bar{I}_b \Rightarrow \bar{V}_b = \left(\frac{R}{R - j\frac{1}{\omega C}}\right)\bar{V}_{an}$$

$$= \left(\frac{R^2 + jR\left(\frac{1}{\omega C}\right)}{R^2 + \left(\frac{1}{\omega C}\right)^2}\right)\bar{V}_{an}$$

$$= \left(\frac{R^2}{R^2 + \left(\frac{1}{\omega C}\right)^2} + \frac{jR\left(\frac{1}{\omega C}\right)}{R^2 + \left(\frac{1}{\omega C}\right)^2}\right)\bar{V}_{an}$$

for $\left(\frac{1}{\omega C}\right) \gg R$ or $\frac{1}{R} \gg \omega C$

$$\bar{V}_{bn} \approx \left(\frac{jR\left(\frac{1}{\omega C}\right)}{R^2 + \left(\frac{1}{\omega C}\right)^2}\right)\bar{V}_{an}$$

* Phase is shifted by 90°. This is (approximate) 2φ power

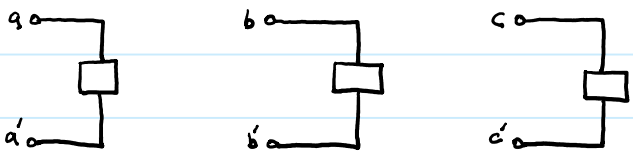
* 2x power as 1φ

* 2x wires as 1φ (4 vs. 2)

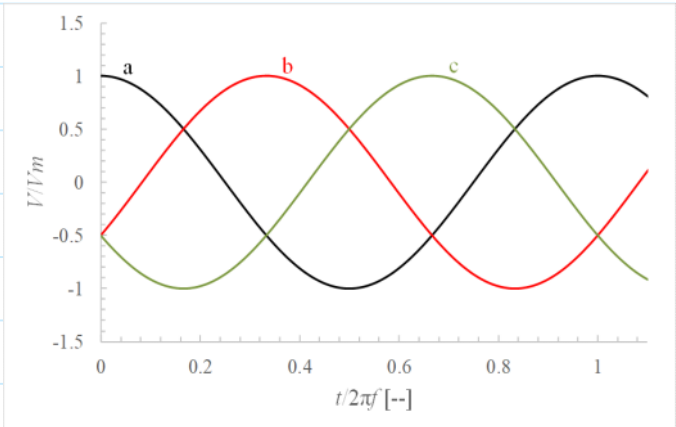
True 2φ: $\bar{V}_{an} = V\angle 0°$, $\bar{V}_{bn} = V\angle 90°$ } Results in rotating magnetic field

*More details later in semester

Even better: 3φ



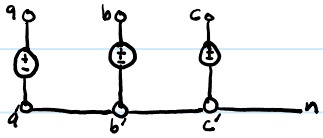
a-b-c sequence



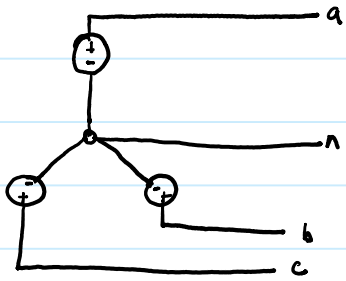
Positive Sequence a-b-c	Negative Sequence a-c-b
$V_{aa'} = V_m\cos(\omega t)$	$V_{aa'} = V_m\cos(\omega t)$
$V_{bb'} = V_m\cos(\omega t - 120°)$	$V_{bb'} = V_m\cos(\omega t + 120°)$
$V_{cc'} = V_m\cos(\omega t + 120°)$	$V_{cc'} = V_m\cos(\omega t - 120°)$

Connecting the 3 phases

1) Wye

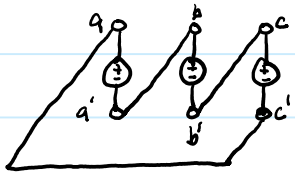


Conventional diagram

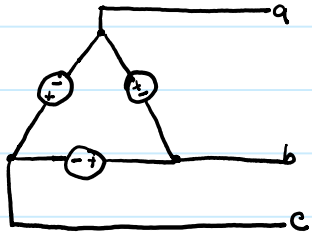


$i_n = i_a + i_b + i_c$

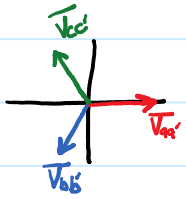
2) Delta



Conventional diagram



$V_{aa'} + V_{bb'} + V_{cc'} = 0$

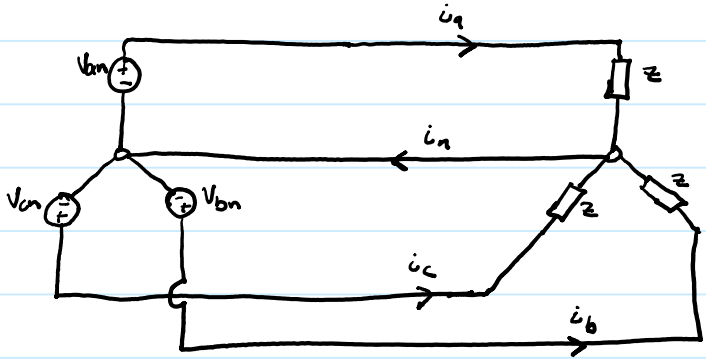


* Loads can also be connected in wye or delta

		Source	
		Wye	Delta
Load	Wye	Wye-Wye	Delta-Wye
	Delta	Wye-Delta	Delta-Delta

Wye-Wye and Wye-Delta are most common connections.

Wye Source to Wye Load



* Balanced load: all impedances equal