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

Transformer
More detail later in semester

Circuit breaker

120/240
1φ 3wire

* 1φ has problems with motors:
  a) Pulsating power
  b) No starting torque
  * Repulsive and attractive forces act through arm to give no torque.
  * However, if something started rotation, it would continue.

Note: Feeder system: Wires have impedances
This problem can be fixed by adding a second phase. How?

\[ I_b = \frac{V_{an}}{R - j\omega C} \]

\[ V_{b} = R I_{b} \Rightarrow V_{b} = \left( \frac{R}{R - j\omega C} \right) V_{an} \]

\[ = \left( \frac{R^2 + jR(\omega C)}{R^2 + (\omega C)^2} \right) V_{an} \]

\[ = \left( \frac{R^2}{R^2 + (\omega C)^2} + j\frac{R(\omega C)}{R^2 + (\omega C)^2} \right) V_{an} \]

for \( (\omega C) > R \) or \( \frac{1}{R} \gg \omega C \)

\[ V_{an} \approx \left( \frac{jR(\omega C)}{R^2 + (\omega C)^2} \right) V_{an} \]

* Phase is shifted by 90°. This is (approximate) 2x power. 2x power as 1φ

**True** 2φ: \( V_{an} = V_{L0°} \) \( \Rightarrow \) Results in rotating magnetic field

**More details later in semester**

Even better: 3φ

Positive Sequence

\[ a-b-c \]

\[ V_{a} = V_{m}\cos(wt) \]

\[ V_{b} = V_{m}\cos(wt - 120°) \]

\[ V_{c} = V_{m}\cos(wt + 120°) \]

Negative Sequence

\[ a-c-b \]

\[ V_{a} = V_{m}\cos(wt) \]

\[ V_{b} = V_{m}\cos(wt + 120°) \]

\[ V_{c} = V_{m}\cos(wt - 120°) \]

a-b-c sequence
Connecting the 3 phases

1) Wye

\[ i_n = i_a + i_b + i_c \]

2) Delta

\[ V_{ac} = V_{a'b'} + V_{b'c'} + V_{c'a'} = 0 \]

*Loads can also be connected in wye or delta*

<table>
<thead>
<tr>
<th>Source</th>
<th>Wye</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wye</td>
<td>Wye-Wye, Delta-Wye</td>
<td>Wye-Wye and Wye-Delta are most common connections.</td>
</tr>
<tr>
<td>Delta</td>
<td>Wye-Delta, Delta-Delta</td>
<td></td>
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</tbody>
</table>

Wye Source to Wye Load

*Balanced load: all impedances equal*