Topics for Today:

- Announcements
  - Office hrs: 2:05pm-2:55pm Mon, Wed, Fri
  - Office: EERC 614. Phone: 906.487.2857
  - XFMR exercises posted on web page, due Fri 5pm.
  - Recommended problems from Ch. 2, solutions posted

- XFMR, Chapter 2 - Transformers and circuits w/transformers
  - Pre-Req Videos 3-6 - View them, study notes!
  - Single phase ideal transformer is building block - V, I, dot convention!
  - 3-phase transformer banks and phase shifts (ANSI/IEEE vs. IEC)
  - Standard 30° shift transformers, non-standard connections
  - Pos/neg sequence phase shifts, sequence networks.
  - Autotransformers
  - Load Tap Changing (LTC) transformers
  - Phase shifting transformers
  - Paralleling transformers with a) unlike impedances; b) unlike tap positions
  - Three-winding transformers
Transformer Phase Shifts

- See Δ-Y transformer nameplate

\[
\begin{align*}
H_3 & \rightarrow H_1 \\
H_2 & \\
X_0 & X_1 X_2
\end{align*}
\]

pos sec voltage "phase" shift

\[
\begin{align*}
\widetilde{V}_{BC} & \rightarrow V_{cb} \\
\widetilde{V}_{c} & \rightarrow V_{ca} \\
\widetilde{V}_{an} & \rightarrow V_{an} \\
\widetilde{V}_{bn} & \rightarrow V_{bn}
\end{align*}
\]
±30°, ±90° ± 150°
SEQUENCE NETWORKS
FOR TRANSFORMERS

\[ I_0, I_1, I_2 \]

[Diagrams of transformer sequences with labels and symbols]
Per Phase Equiv:

- \( V_{AN} \)
- \( L-N \) per phase equiv
- Per Unit Values:
  - \( V \)
  - \( I \)
  - \( Z \)
  - \( Y \)
  - \( P \)
  - \( Q \)
  - \( S \)
TRAP: Text books have "cook-book" eqns assuming that all transformers are std. 30°. WRONG!

MANY OTHER OPTIONS
 ±30°, ±90°, ±150° Δ-Y, Y-Δ
pop to

is X

A0

yes

open? (if Δ is open)

zero ref.
$Z = \infty$

$Z_{in} \Rightarrow Z_c \Rightarrow \frac{Z_c}{R_c}$

$Z_{in} = R + j\omega L + Z_{can}$
\[ V_{\text{drop}} = 3I_{AO}Z_n = V_{NG} \]
triplet harmonics
buried tertiary
buried delta

delta: - trap triplet harmonics
    - zero seq circ path
    - Aux power (station service)
    - Protection
    - CTs