Topics for Today:

- Parameters obtained from LINE CONSTANTS
- Duality Transforms for Transformer models
- Intro to Lightning, Surges (Switching & Lightning)

ATP Simulation Pointer for the day:

Review of conductor radius vs. GMR (from undergrad power systems courses):

Actual radius of a conductor is correct to use for capacitance calculations.

\[ C \propto \frac{1}{\log\frac{D}{2r}} \]

Inductance consists of internal plus mutual effects. Using actual radius of conductor in calculation gives only the mutual effect. If the actual radius is "corrected" the mutual inductance equation can be used to calculate total inductance.

\[ L \propto \log\frac{DEQ}{GMR} \]
For solid conductor, this is:

\[ r' = r e^{\frac{1}{4}} \]

\[ e^{\frac{1}{4}} = 0.7788 \]

Note that internal inductance for stranded conductors depends on current density distribution (skin and proximity effects).

\[ \text{ACSR} = r' \text{ given by conductor tables.} \]

\[ \text{skin effect} \]
\[ \text{& proximity effect} \]

\[ \text{ACSR} = 954 \text{ kcmil} \]

\[ \frac{1.519}{1.229} = 1.229 \]

\[ \frac{r}{r'} \]

\[ \text{GMR}_{\text{CAP}} = \sqrt{dr} \]

\[ \text{GMR}_{\text{IND}} = \sqrt{dr'} \]
Static Wire:

\[ r = 0.489 \text{ cm} \quad \text{Steel} \]
\[ r' = 0.0656 \text{ cm} \quad \text{(typical)} \]

Cap Matrix

KROHN Reduction - (Matrix Reduction)

\[
\begin{bmatrix}
14 	imes 14 \\
C
\end{bmatrix} \Rightarrow \begin{bmatrix}
3 	imes 3 \\
C
\end{bmatrix}
\]
CAPs HAVE Admittance Topology

\[ Y = Z + j\beta \]
\[ Z = \frac{1}{\omega C} \]

IF \( r = 0 \), \( x_c = \frac{1}{\omega C} \)

\( B_c = \omega C = Y \)

For capacitive effect,

\[ [Y] = \omega [C] \]
\[
\begin{bmatrix}
C_{AB} + C_A + C_{AC} & -C_{AB} - C_A - C_{AC} \\
-C_{AB} & C_{AB} + C_B + C_{BC} - C_B \\
-C_{AC} & -C_{BC} \\
C_A + C_C + C_{BC}
\end{bmatrix}
\]

\[R \quad \underline{\omega L}\]

\[B \Rightarrow [Z_s] = [A]^{-1} [Z_p] [A]
\]

\[ [Z_p] = [A] [Z_s] [A]^{-1} \]
\[
[z_5] = \begin{bmatrix}
  z_{00} & z_{01} & z_{02} \\
  z_{10} & z_{11} & z_{12} \\
  z_{20} & z_{21} & z_{22}
\end{bmatrix}
\]

If off-diagonal values of \([z_5]\) are zero.
DUALITY TRANSF. "PAIRS"

\[ N I = \text{MMF} \quad \left\{ \begin{array}{c}
\text{NODE} \\ \text{MESH}
\end{array} \right. \quad \left\{ \begin{array}{c}
\text{MESH} \\ \text{NODE}
\end{array} \right. \quad I_{\text{SOURCE}} \]

\[ R \\ \quad \\
L = \frac{N^2}{R} \]

\[ L = \frac{N^2}{R} \]
FLOATING

OTHER EXAMPLES
Duality Derivations:

Simple XFMR:

Note! KVL around Mag CKT loop must have same relative signs as currents, KCL dual.
Figure 2. Cross section view of CT

Since it has concentric windings (the primary is effectively one turn) the circuit of Figure 1 is invalid. Therefore, a transient model in the EMTP [3].

A cross section view of the CT is shown in this study is shown in Figure 2. It has a one turn primary and a toroidal core.
Figure 3. Duality Derivation for the CT

EX. 2

digital oscillilloscope was used to record the voltage and
nonsinusoidal above 30 volts. To avoid this problem, a
highly low voltage, and the currents for this CT became
since it requires the measurement of real power at a refer-
This test is difficult to perform with a typical watthour,

Therefore, if I is invalid. Therefore, a
load now and short-

Flux Path 3
Flux Path 1
Flux Path 2

[TIP]