Topics for Today:

• Announcements
  • Detailed term project outlines (i.e. Table of Contents + List of references
  • Software: can apply for ATP/ATPDraw license, verify licensing when you receive it by e-mail, and we will mail you the install CD.
  • ASPEN software - remote desktop to MTU server.
  • Office Hrs: EERC 123, WF, 4-6pm.
  • Recommended problems & all solutions: Ch.7 solns posted.

• Chapter 7 - Network Equations, Admittance Approaches
  • Overview of off-nominal xfmrs
  • Double-circuit lines - mutual coupling
  • Network Reduction (Kron Reduction)
  • Solution of matrix equations (system of linear equations)
  • Lead-in to Short-circuit and other formulations.
  • Upcoming homework - intro to Matlab, matrices, equations.
Term Project

- Literature Search
- Write the Background section:
  - Intro, Prob Def., Motivation
- Develop
- Develop/implement
- Journal Paper Review
Buses:
- LOADS (\(\text{Const}Z\); \(\text{Const} P,Q\); \(\text{Const} I_j\); ...)
- GENS (Norton Equiv: \(I_{\text{inj}}\parallel Y_N\); \(\text{Const} P,Q\))
Goal: Only buses of interest need be observable.

Constraint: Must retain source nodes (nodes at which current is being injected).

Steps:
1) Reorder system - move buses to be kept to top, i.e. 1,...,K
   Remaining L...Z nodes are absorbed into system.

2) Perform Kron Reduction.
\[
\begin{bmatrix}
[K] & [L] & [V_A] \\
Y_{bus} & Y & Y \\
\end{bmatrix}
\begin{bmatrix}
I_A \\
I_x \\
I_{inj} \\
\end{bmatrix}
\]

1. \( I_A = KV_A + LV_B \)
2. \( I_x = L^TVA + MV_B \)

Since \( I_x = \begin{bmatrix} 0 \\ \vdots \end{bmatrix} \)
\( 3. \quad -L^T V_A = M V_B \quad \text{From Egn. 2} \quad \text{for } \hat{I}_x = 0. \)

\( 4. \quad -M^T L^T V_A = V_B \quad \text{premultiply both sides by } M^{-1}. \)

Substituting \( V_B \) into Egn. 1,

\[
I_A = K V_A - L M^T L^T V_A
\]

\[
[I_A] = [K-LM^T L^T][V_A]
\]

The \([Y_{bus}]\) for this reduced system is thus implied to be \([K-LM^T L^T]\).

Derivation assumes bilateral system (note \( L, L^T \))
Reduced $[Y_{bus}]$ is

$$
[Y_{bus\ Reduced}] = K - L M^T L^T
$$

**Important Observation:**

If $L$ & $L^T$ are off-diagonals, then this eqn. only valid for bilateral system.
\([Y] = [Z] \quad (\text{[Ybus]} = \text{[Zbus]})\)

Look at \([Z]\) in regards to S.C. calcs.

If \([Z]\) is symmetric about the main diagonal (bilateral) then use either row or col.
Begin with practical use of \[ \ell \]

Thevenin Impedance: Main diagonal element of \( [Z] \)

Useful to know \( 2\text{m} \) of bus \( \ell \)

\[
\text{Prefault Voltage: } V_{\text{Bus1}} = \frac{V_{\text{Bus2}}}{2k}
\]