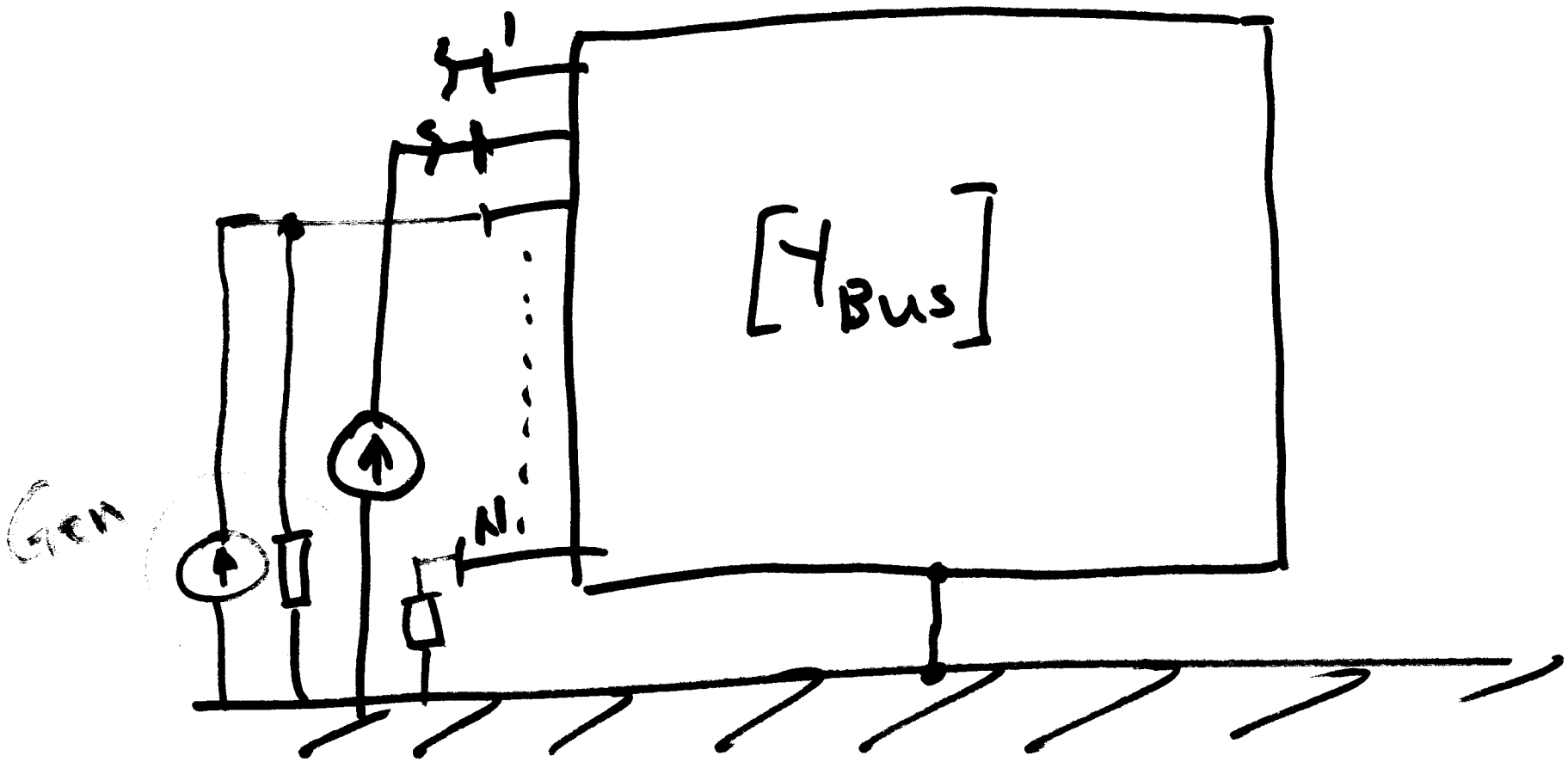
Topics for Today:

- Announcements
  - Detailed term project outlines (i.e. Table of Contents + List of references
  - 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:

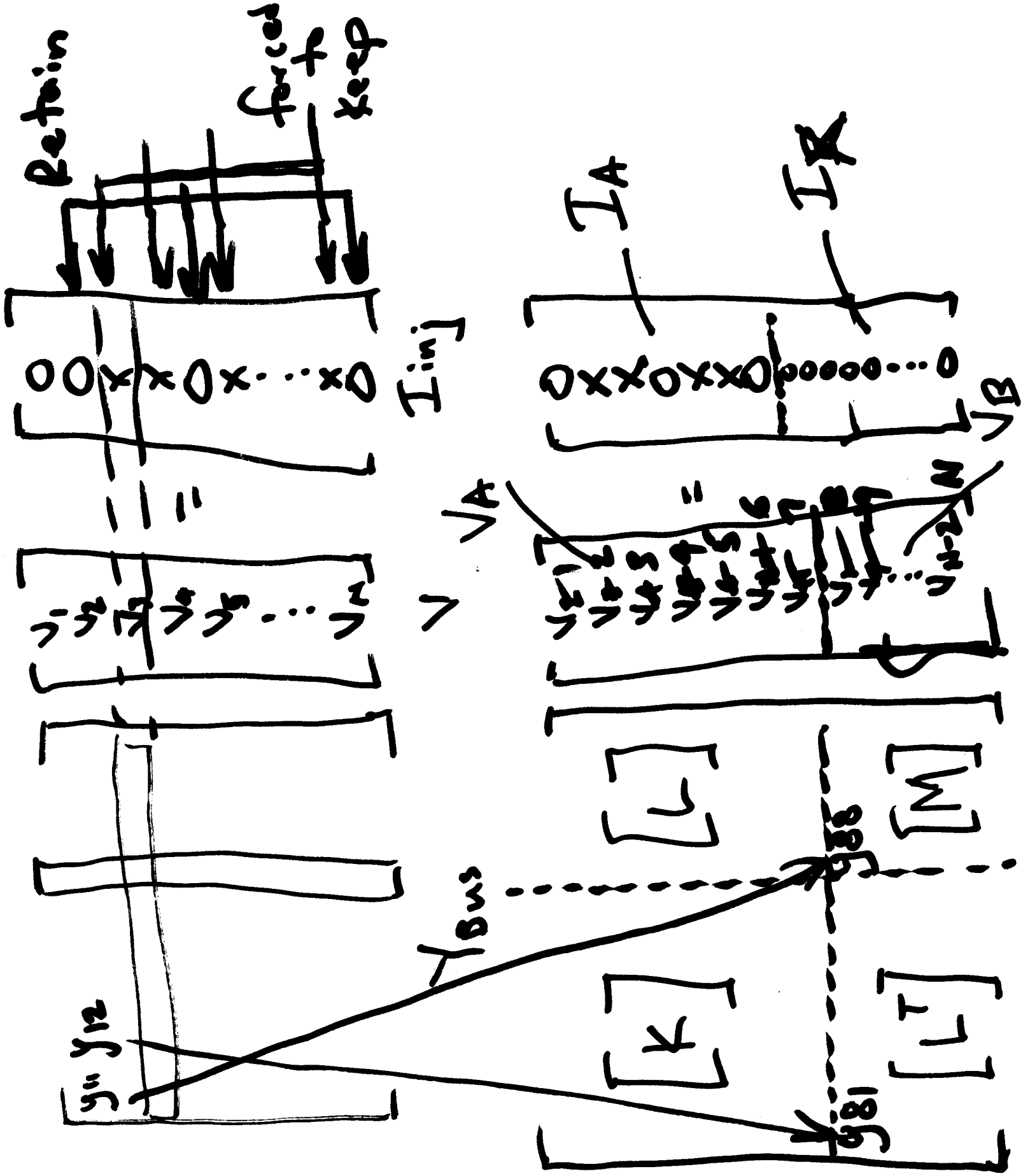
- LOADS (Const Z; Const P,Q; Const I; ...)
- GENS (Norton Equiv: I_{inj} // Y_N; Const P,Q)

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.



$$\begin{array}{c} \\ K \\ L \end{array}\begin{array}{c} \begin{array}{cc} 1 & \quad K \end{array} \\ \begin{bmatrix} [K] & [L] \\ [L^T] & [M] \end{bmatrix} \end{array}\begin{array}{c} \\ K \\ L \end{array} \begin{bmatrix} V_A \\ V_B \end{bmatrix} = \begin{bmatrix} I_A \\ I_X \end{bmatrix}$$

Y_{BUS} $\quad V \quad I_{inj}$

retain all sources!

① $I_A = K V_A + L V_B$

② $I_X = L^T V_A + M V_B$

Since $I_X = \begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}$

③ $-L^T V_A = M V_B$ ← From Eqn. ② for $I_x = 0$.

④ $-M^{-1} L^T V_A = V_B$ ← premultiply both sides by M^{-1}.

Substituting V_B into Eqn. ①,

$$I_A = K V_A - L M^{-1} L^T V_A$$

$$[I_A] = \underbrace{[K - L M^{-1} L^T]}[V_A]$$

The $[Y_{BUS}]$ for this reduced system is thus implied to be $[K - L M^{-1} L^T]$.

Derivation assumes bilateral system (note L, L^T)

Reduced $[Y_{bus}]$ is

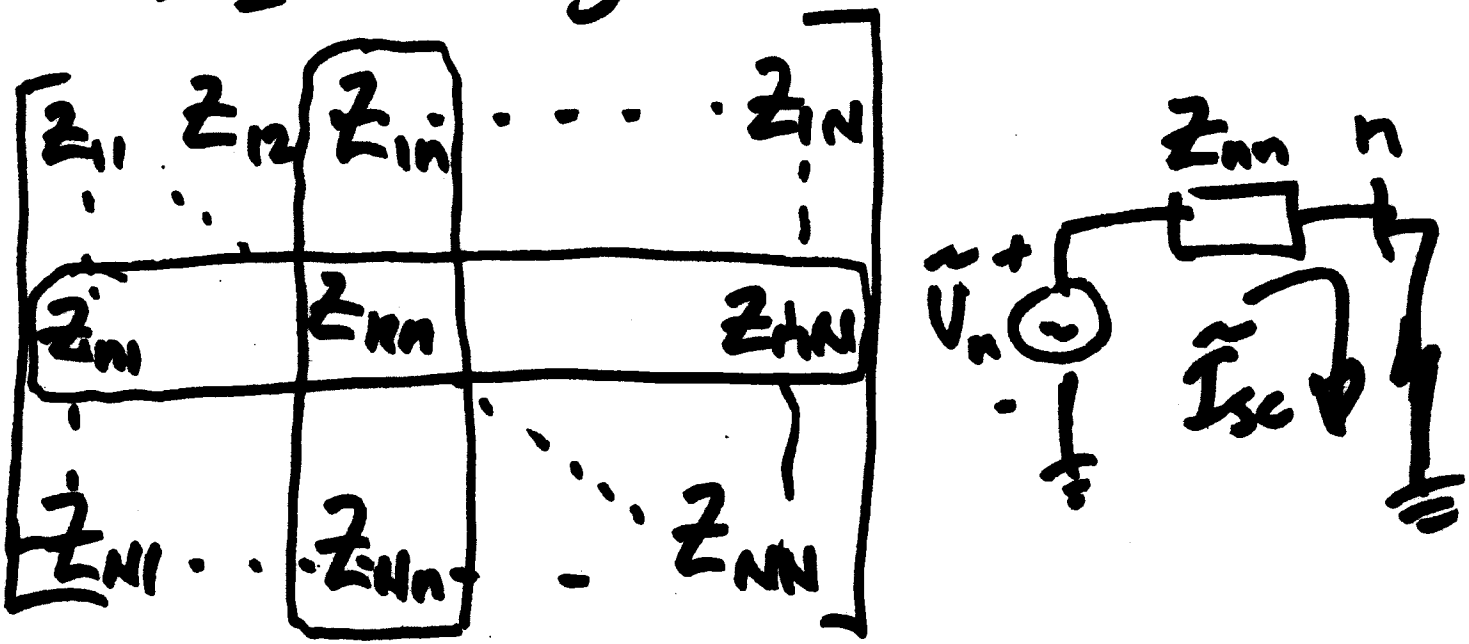
$$\left[Y_{bus}^{Reduced}\right] = K - LM^{-1}L^{T}$$

IMPORTANT OBSERVATION:

If L & L^T are off-diagonals, then this eqn. only valid for bilateral System!

$$[Y]^{-1} = [Z] \quad \left([Y_{BUS}]^{-1} = [Z_{BUS}] \right)$$

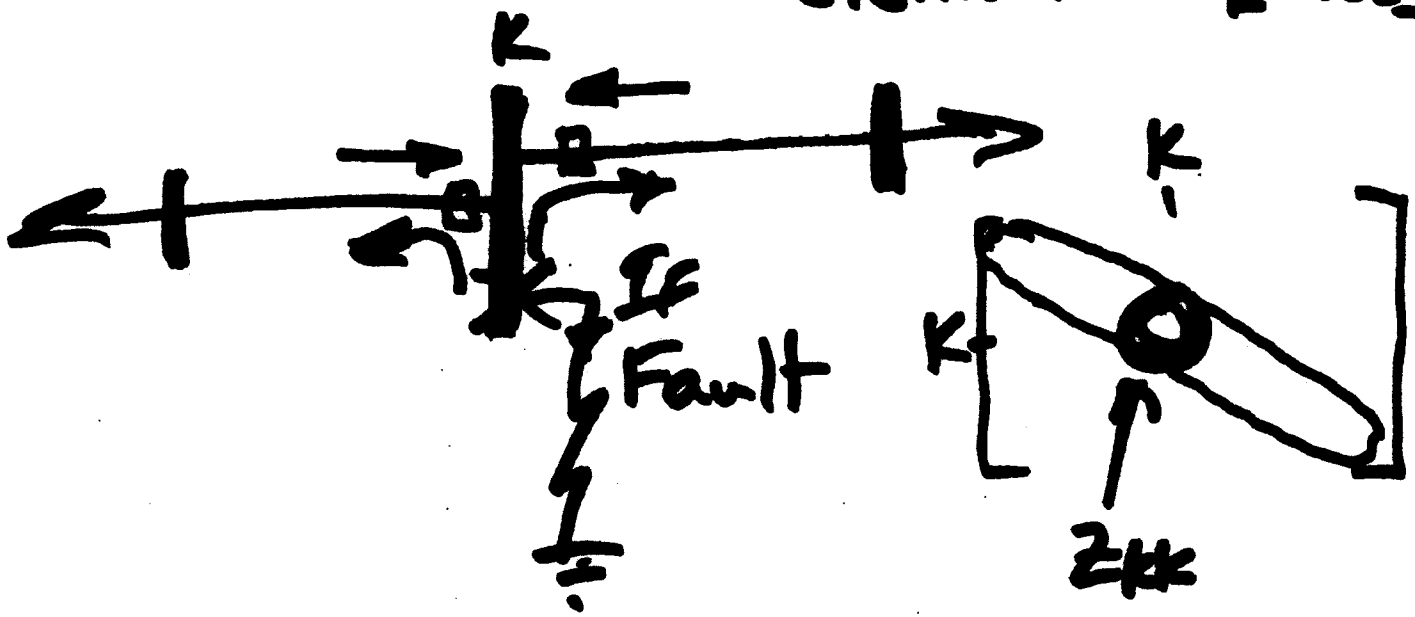
Look at [Z] in regards to S.C. calcs.



If [Z] is symmetric about the main diagonal (bilateral) then use either row or col.

Begin with practical use of [Z]

Thevenin Impedance: Main diagonal element of $[Z_{bus}]$



Useful to Know Z_{TH} at bus