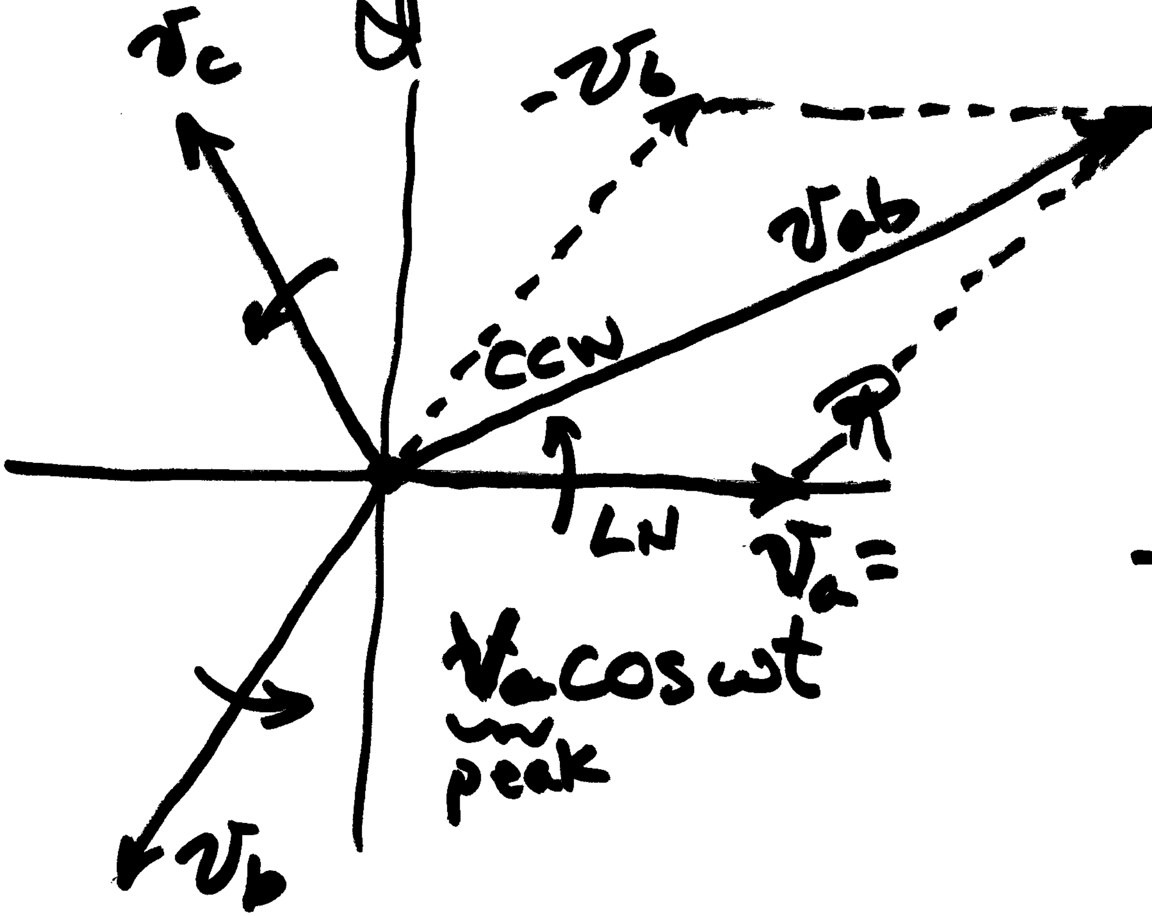
**EE 5200 - Lecture 2** Tuesday Aug 28, 2003

**Topics for Today**:

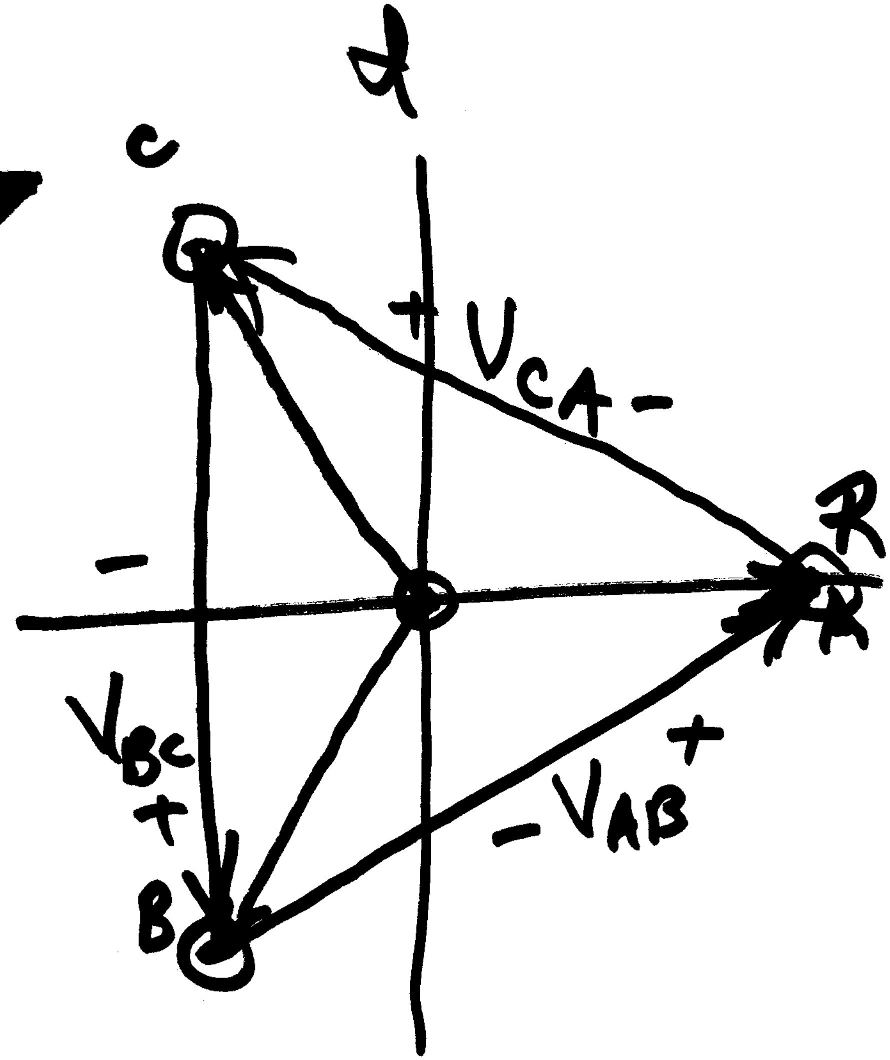
- Announcements
  - EE5200-L@mtu.edu now working. Use it.
  - Bring calculator to lectures, for in-class sample calculations.
  - Buy a 2" 3-ring binder for course materials.
  - Room B45 is open from 9am onward.
  - Office hrs: 1:30-2:30pm, Mon, Wed, Fri
  - Office: EERC 623. Phone: 906.487.2857
  - Ch.1 Solutions posted on web page. Finish by Sept. 5th.
  - Set of pre-req / review exercises given out next week.
- Continuing with Chapter 1 / Review:
  - Ideal transformer: V, I, S, P, Q relationships
  - Nodal Analysis: Forming node equations [Y], [Z], [ I ], [V]
  - Matrix description of system, physical meaning.
  - Three-phase analysis, per-phase (L-N phase-A) equivalent.
  - Per Unit system
  - Symm Comp.

# Phasor Diagrams

$v_{ab} = v_a - v_b$



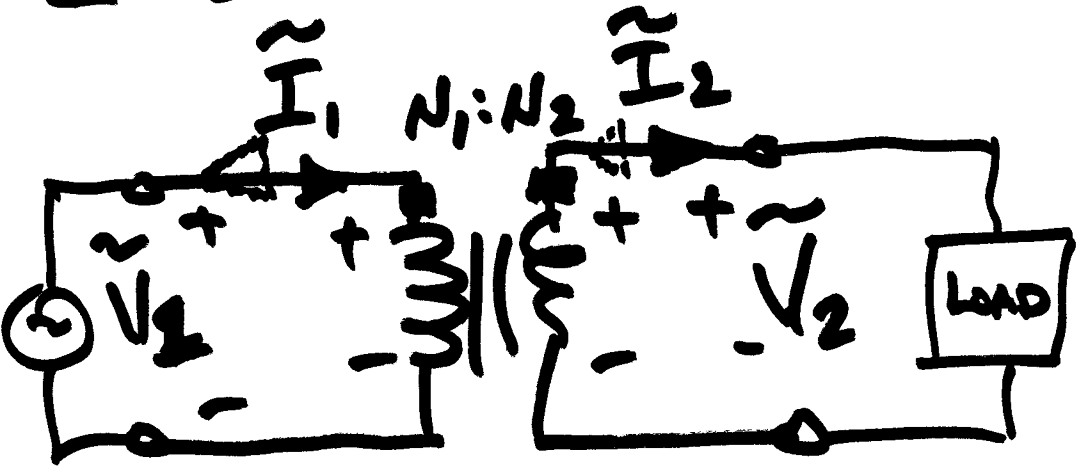

Time Domain

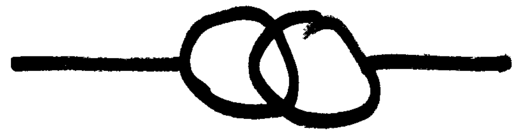



Phasor Domain

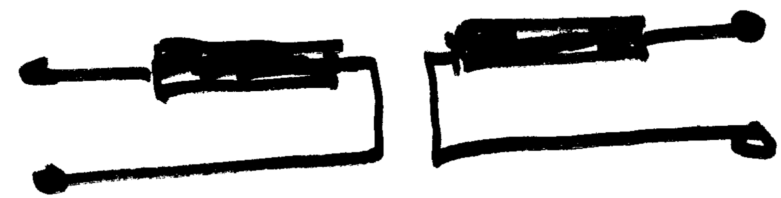
# IDEAL TRANSFORMER





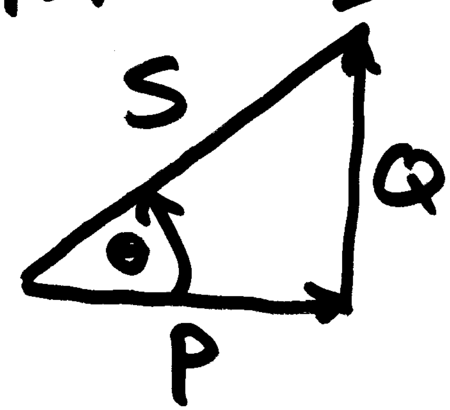

IEC 

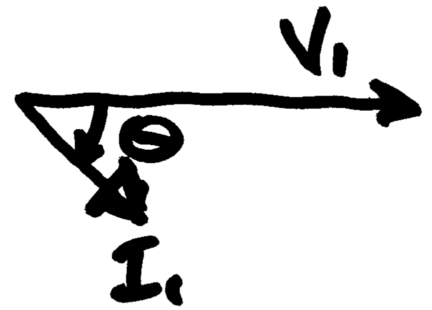
IEEE 

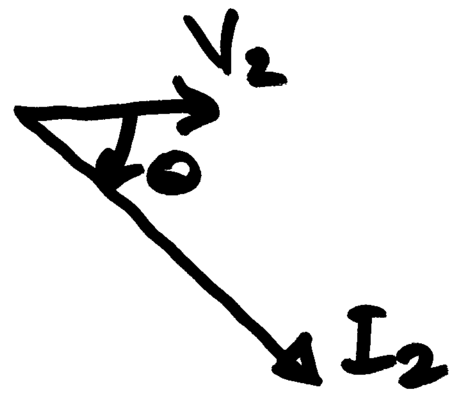


$$VA_{IN} = VA_{IN}$$

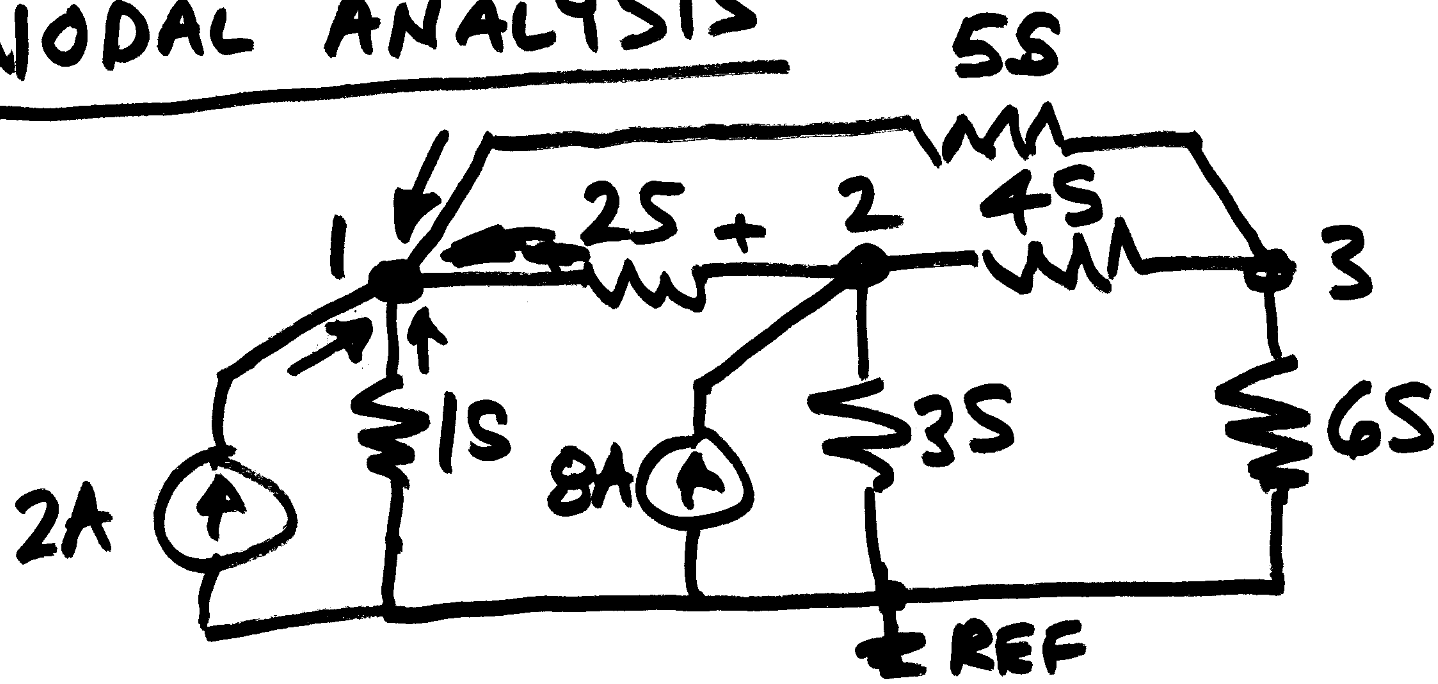
$$\bar{S}_1 = \tilde{V}_1 \tilde{I}_1^* = \tilde{V}_2 \tilde{I}_2^* = \bar{S}_2$$



# NODAL ANALYSIS




$G = \frac{1}{R}$

$S = \frac{1}{X}$

$Y = \frac{1}{Z}$

KCL: $\Sigma I_{s_{IN}} = 0$

KCL:

① $2 + (V_2 - \underline{V_1})2 + (V_3 - \underline{V_1})5 + (-\underline{V_1})1 = 0$

② $8 + (V_1 - \underline{V_2})2 + (V_3 - \underline{V_2})4 + (-\underline{V_2})3 = 0$

③ $0 + (V_2 - \underline{V_3})4 + (V_1 - \underline{V_3})5 + (-\underline{V_3})6 = 0$

$\Longrightarrow \quad [Y][V] = [I_{inj}]$

each y:

$y = g + jb$

$$\begin{bmatrix} 2+5+1 & -2 & -5 \\ -2 & 2+4+3 & -4 \\ -5 & -4 & 4+5+6 \end{bmatrix} \begin{bmatrix} \tilde{V}_1 \\ \tilde{V}_2 \\ \tilde{V}_3 \end{bmatrix} = \begin{bmatrix} +2 \\ +8 \\ 0 \end{bmatrix}$$

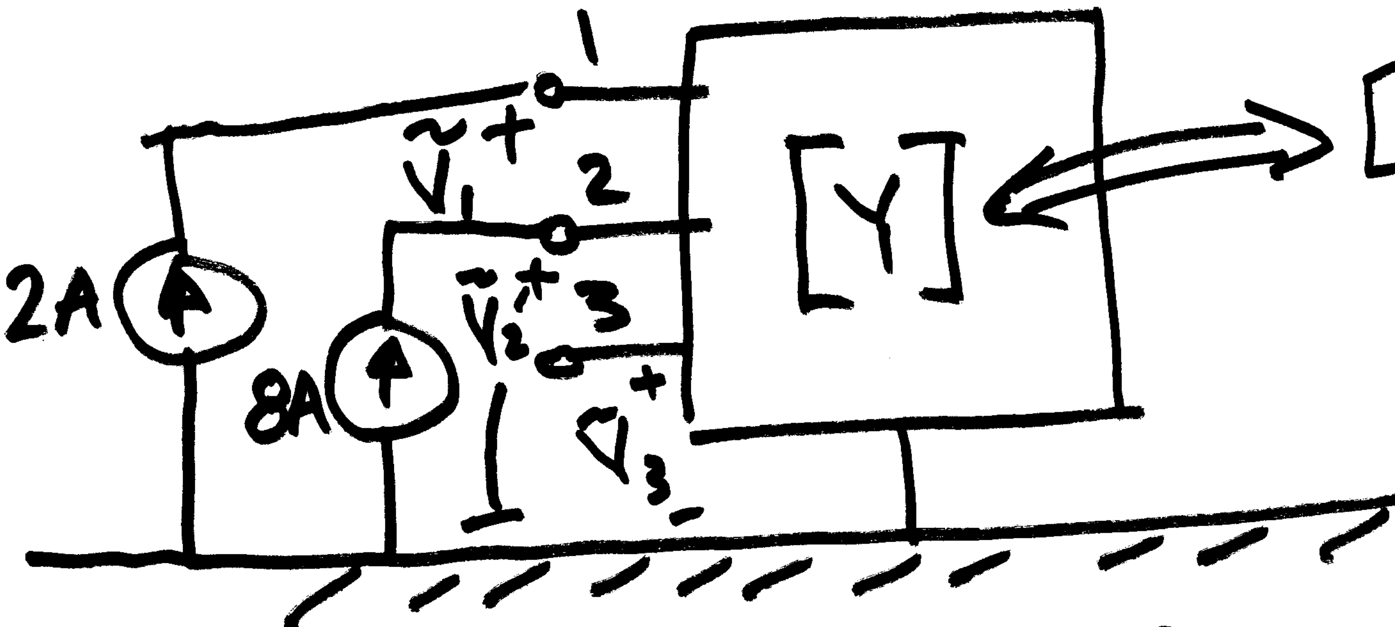
$[Y]$ is symmetric about main diagonal (unless we have phase-shifting xfmrs or FACTS devices in system).

<u>Notes</u>: <u>Rules</u>

$$\begin{bmatrix} y_{11} & y_{12} & y_{13} \\ y_{21} & y_{22} & y_{23} \\ y_{31} & y_{32} & y_{33} \end{bmatrix} \Leftarrow$$

1) Off-diagonal admittances are:
$y_{nk} = -\sum$ of "spanning" branches.

2) Main-diagonal admittances
$y_{KK} = +\sum$ of the connected admittances.




$[Z] = [Y]^{-1}$

Why use [Y] instead of [Z]?
i.e. why use nodal analysis and admittances?

[Y] is very <u>sparse</u>!

$[Y]^{-1} = [Z]$ is a <u>full</u> matrix.

Correct terminology:
~~[illegible]~~ "Y-Bus" [Y]: Nodal Admittance Matrix
"Z-Bus" [Z] = " Impedance Matrix