Topics for Today:

- Course Info:
  - Web page: [http://www.ee.mtu.edu/faculty/bamork/ee5220/](http://www.ee.mtu.edu/faculty/bamork/ee5220/)
  - Software - Matlab. ATP/EMTP [ License - www.emtp.org ] ATP tutorials posted on our course web page
  - [EE5220-L@mtu.edu](mailto:EE5220-L@mtu.edu) (participation = min half letter grade)

- HW#6 - due latest Mon Mar 5th 9am.
- Term Project - reference list and table of contents (outline) of project work by end of this week, via e-mail to Dr. Mork.
- ATP Simulation pointers
- Transmission Line Models available in ATP (more detail on these later)
  - Lumped Pi
  - Bergeron
  - Marti
  - Semlyen
  - Noda
- Use of ATPDraw’s Line Constants to obtain parameters, build line models.
- Use of Line Constants .lis output file to obtain detailed matrices, line parameters, propagation constants.
ATP Simulation Pointers for the day:

Switching operations cause a step response in the system you’re simulating. If numerical oscillations should occur upon a switching operation, it may very likely be due to a very small source inductance. This is typical in very small Ls or very large Cs. In this case, first add numerical damping to the small L. This usually solves the problem.

The new time-controlled switch in ATPDraw allows many on-off cycles of switch. If you are paralleling the older/simpler switches (which only allow one on-off cycle) for complex operations, then a small R can be inserted in series with the second and later switches.

Insert a current probe (internal to ATP this is called a “measuring switch” or “metering switch”) in series with other elements if you want to measure the current flowing into a particular node in your system.
ATP Simulation Pointer for the day:

When simulating a multi-step switching operation, switches can be placed in parallel. However, this topology can cause some numerical instabilities, especially with a voltage-controlled switch. To avoid this problem, you can insert very small resistances in series with the additional switches.

\[ R = 10^{-5} \Omega \]

or \[ 10^8 \Omega \].
Initialization

\[ V(0) = 0 \]

\[ \text{TERRA or } \]
Nonlinear Inductors

10^-5

In ATP "STARTUP" = 1.0 - 8
On a one-line:

In ATP: "PI Model:

"Carson’s Rule"

- KRON REDUCTION
For all line models.

Zero-impedance each return (perfect grid plane)
Bergeron - Constant $Z_c$. (not freq. dep)
Marti Model - freq-dependent \( Z_c \)

Build if for \( 1 \text{Hz} \rightarrow 1 \text{MHz} \)
Transposition - Balance phase Z, Y, for lines which are "asymmetric" e.

"Symm"

"Horizontal"
non-symm
phase spacings

⇒ Transposition.
Unbalanced V-drops, hence unbalanced phase voltages at receiving end of line.

Transposed (Continuously transposed)
For actual lines, model each line section separately.

Transpose by "rolling" the phase connections between sections.
\[ \begin{bmatrix}
   C_{aa} & C_{ab} & C_{ac} \\
   C_{ba} & C_{bb} & C_{bc} \\
   C_{ca} & C_{cb} & C_{cc}
\end{bmatrix} \]

\[ \text{C}_{nn} = + \sum \text{Connected} \ C_s. \]

\[ Y = G + j \omega C = \]

\[ i_A = \]

\[ i_B = \]

\[ i_C = \]
Line Charging Example: LCC_3b.alc (Coupled-PI, 60 Hz model).

Simulation file: Line_Chg.acp

As predicted, phase B line current is larger than A or C, due to larger capacitive coupling to phase B. Larger capacitive effect => smaller input impedance => higher current...

See Line Constants output log file, LCC_3b.lis, on following pages. Be sure to print these with fixed-pitch font so that columnar data is aligned. This file is created in atp\atpdraw\atp\ folder when you "build" the line model (from within Line Constants parameter/dialog box, click on Run ATP).