Topics for Today:

• Course Info:
  • Web page: [http://www.ee.mtu.edu/faculty/bamork/ee5220/](http://www.ee.mtu.edu/faculty/bamork/ee5220/)
  • Book, references, syllabus, more are on web page.
  • Software - Matlab. ATP/EMTP [ License - [www.emtp.org](http://www.emtp.org) ] ATP tutorials posted on our course web page
  • [EE5220-L@mtu.edu](mailto:EE5220-L@mtu.edu) (participation = half letter grade, 5%)

• Term Project - Final Report - completed by Fri April 23rd
• Term Project - On-campus teams present on Tues Apr. 29th, 12:30 --
• Applications in 3-phase systems - Chapter 5, 6, 17
  • Three-pole switching, CB issues
    • Cap Bank Switching (deenergization)
    • Reactor Switching (deenergization)
  • Synchronized switching for energization
    • Cap banks, Reactors, Transformers
• Next - work thru class demo/simulations of these switching scenarios
Tues Presentations?

11:00 - 12 noon - conflict

12:30 -
3-pole Switching

Synchronized Switching

Energizing at voltage zero would eliminate the inrush current.
In practice, it's possible to control CB to within ±20° of desired phase angle.
\[ V_C(0) = -2V_p + 3V_p \]

\[ I_p = \frac{V_p - V_C(0)}{Z_0} \]
De-energize 3-ph Cap Bank

\[ \text{§6.2 - Ex. } \Phi A \text{ opens first.} \\
\text{No problem: both neu grounded.} \\
\text{What if Load neu is open?} \]
New voltage shifts:

- $\phi_A: \sqrt{2} V_{LL}/2$
- $\phi_B: \sqrt{2} V_{LL}/2$
- $\phi_C: \sqrt{2} V_{LL}/2$
Synch Switching - Minimize Inrush.
- Depends on: initial $f$ (\( f(0) = ? \))

If we knew that $f(0) = 0$, then close CB at $\pm V_p$.

However... $-0.677p < f(0) < +0.677p$

worst case $f_p$
- Brunke, BPA
- Chiesa

5 nonlinear LM's

Close φA first
Vin2 on φB & φC (known - Magnitudes - Phase Angles)
- Close φB (synchronized)
- Close φC (""")
Case 1a - with new.
Case 1b - ungrounded.

\[ \Rightarrow + \text{ acp} \]

Case 2 - Statistical Sw.
Synch Closing!

Case 3 - Reactor Switching.
\[ w_0 = \frac{1}{\sqrt{LC}} \]