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 (participation = half letter grade, 5%)

- HW#5 will be posted. Partnered exercise. Due Mon Feb 25th 9am.  
- Section 12.4 - detailed derivation for capacitor  
- Prob 5.3 - first do ATP simulation, then Hand Calculations  
- Prob 5.6  
- Term Project - proposed topic(s) by end of this week, via short e-mail.  
- ATP Implementation Details  
  - Considerations for network formulation (KCL, nodal equations)  
  - Realization that [Y] is completely real, i.e. [G] for ATP's formulation.  
  - Solution method if Vs are known  

- Circuit Breakers - Interruption issues  
  - Restrike  
  - Reignition

- Cap Sw.  
- Reactor Sw.
A term project shall be done in lieu of a final exam. The project you choose:
- must be of topical interest, and must relate to course material of EE5220.
- is sufficiently researched (referenced) and documented, including at least one in-depth
  analysis and presentation of the concepts of the journal paper that is most related to this
  work.
- must apply theory and concepts, develop and implement a solution or design method,
  produce results, and make conclusions and recommendations.
- must demonstrate graduate-student level of mastery of the concepts and material.
- length of body of report: approximately 10 pages of text (not including figures, tables, or
  equations).

Time line and required submissions are as follows, all deliverables contribute to the grade
of your term project, i.e. 15% of your course grade. Approximate schedule is:
- Week 6 (Friday): submit short e-mail with idea(s) requesting instructor feedback.
- Week 7 (Friday): submit formal outline of project and list of key references.
- Week 9: submit updated outline of project and complete reference list.
- Week 11: journal paper analysis and presentation (also counts as mini-lecture)
- Week 12: Submit rough draft of project report
- Week 14: Submit final report/deliverable.
- Finals week: present/demonstrate project during final exam time-slot.

Report Outline:
Front Matter:
- Title Page
- Executive Summary (not needed for initial draft)
- Table of Contents (use as "working outline")

Body of report:
- Introduction (brief overview of project: problem area, motivation, overview of project)
- Background
  - literature search, most important references
  - Presentation of key concepts connected with project
  - Identification of existing voids or weaknesses, and resulting opportunity
- Proposed Approach
  - Overview of basic idea that you will develop and implement
  - Development and implementation details
- Implementation (may not be complete in draft versions)
- Results (Expected Results in draft versions)
- Conclusion
- Recommendations for Continued Work

Supplemental Information:
- Reference List (number references [1], [2], etc, in order of first author's last name)
- Appendices as required to document details

Suggested layout:
- Font: 11-pt G6 Times w/1.25-1.5 line spacing; or 10-pt comic or ariel w/1.0-1.25 line space
- Page layout: 1" margins, include page numbering within margin area.
When CB opens, source side drops.

\[ V_t = V_s - jL \frac{dy}{dt} \]

\[ L = \frac{V}{I} \]

\[ \sqrt{2} = \sqrt{V_s^2 + (jL \frac{dy}{dt})^2} \]

\[ \text{increase} \]

\[ \frac{\partial}{\partial t} \left( jxL_c \right) \]
$U_T(t)$

$\Delta V \approx 2.37$

$V_p$

$i(t)$

$-V_p$

$\text{open CB}

\text{open}$

$U_T$

$C_B$

$C_{\text{Bush}}$

$\uparrow$

Table 13.4

$C_{\text{Bush}}$
CAP BANK CB Application

\[ V_s \]

\[ Z_s \]

\[ I_{\text{cap}} \]

\[ V_{\text{cap}} \]

\[ V_{\text{system}} \]

TRAPPED CHARGE

V across open CB contact

Resign Risk

Vp

2Vp

Vp
Restrike - Breakdown later than $\frac{1}{2}$ cycle.
Reignition - Breakdown less than $\frac{1}{2}$ cycle.

Simulate Restrike at $\frac{1}{2}$ cycle

$$ I_p = \frac{2V_p}{\sqrt{2}L} \quad f_0 = \frac{1}{2\pi \sqrt{LC}} $$

\[ V_{\text{max}} = 3V_p \]

Next: On first breakdown, $V_p\ldots$
Reactor Switching
(Other Restrikes)

Consider Opening of CB:
- Energy Trapped in \( L_2 \) Oscillates with \( C \).

Series \( L_2C \) resonance

\[
\omega_0 = \frac{1}{\sqrt{L_2C}} \quad \text{(in KHz range)}
\]

If (when?) a restrike occurs?
\[ W_{02} = \frac{1}{\sqrt{\frac{L_1 L_2 C}{L_1 + L_2}}} \]

Since \( C \) is very large impedance compared to the \( L \)'s

\[ i_1 = i_2 = \frac{V_p(0) + t}{L_1 + L_2} \]

\[ i_1 = \frac{L_2}{L_1 + L_2} \text{ i}_{\text{cap}} \]

\[ \text{ramp} \]

[Drawing of a ramp wave]