EE 5220 - Lecture 13 Monday Feb 5, 2024

Topics for Today:

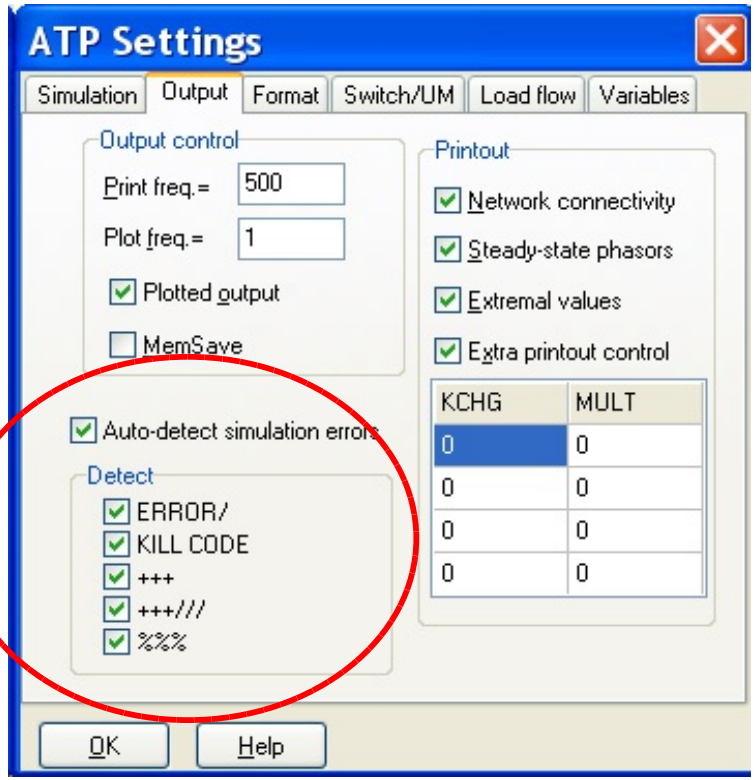
- Startup
  - Web page: https://pages.mtu.edu/~bamork/ee5200/
  - Software - Matlab. ATP/EMTP [License - www.emtp.org]
    ATP tutorials posted on our course web page
  - EE5220-L@mtu.edu (participation = min half letter grade)

- HW#5 will be posted. Partnered exercise. Due Tues Feb 20th 9am.
- ATP Simulation pointers: 3-phase node naming, enabling error messages
- Cap Bank Switching
- ATP - how it works internally
  - History of program development, versions available
  - Rs, Ls, Cs
  - Transmission lines
- Circuit Breakers - Interruption issues
  - Restrike
  - Reignition

ATP Simulation Pointers for the day:

When building 3-phase circuits, you are actually drawing a one-line which represents the L-G per-phase equivalent of the system. Node names have a base name 5 characters long, with the 6th character A, B, C automatically added. Click on the 3-phase end of the splitter if you want to define the base node name.

When building up a circuit for the first time or doing major revisions, it can be convenient to enable the display of error messages:



EE 5220 Term Project (updated: Feb 5, 2024) **2 Persons/team** (Not 1. Not 3.) Spring 2024

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.
- Plagiarism or re-use of past reports or projects is strictly prohibited.
- 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. Follow IEEE standard format in listing and calling out references.
- must apply theory and concepts, develop and implement a simulation or design method, produce results, and make conclusions and recommendations. Can include lab verification.
- 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. Approximate schedule is:
- Week 6 (Friday): submit short e-mail with idea(s) requesting instructor feedback.
- Week 8 (Friday): submit formal outline of project and list of key references. *
- Week 9: submit updated outline of project and complete reference list.
- Week 12: journal paper analysis and .ppt presentation (also counts as mini-lecture) *
- Week 12: Submit rough draft of project report, working protype of base case sim *
- Week 14: Submit final report/deliverable.
- Finals week: be prepared to present/demonstrate project during final exam time-slot.

* graded major milestones.

Report Outline:

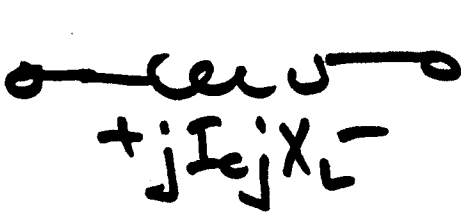
Front Matter (number pages i, ii, iii, iv, v, ...):
- Title Page
- Executive Summary (not needed for initial draft)
- Statement of contributions, signed off in agreement by each team member.
- Table of Contents (use as "working outline")

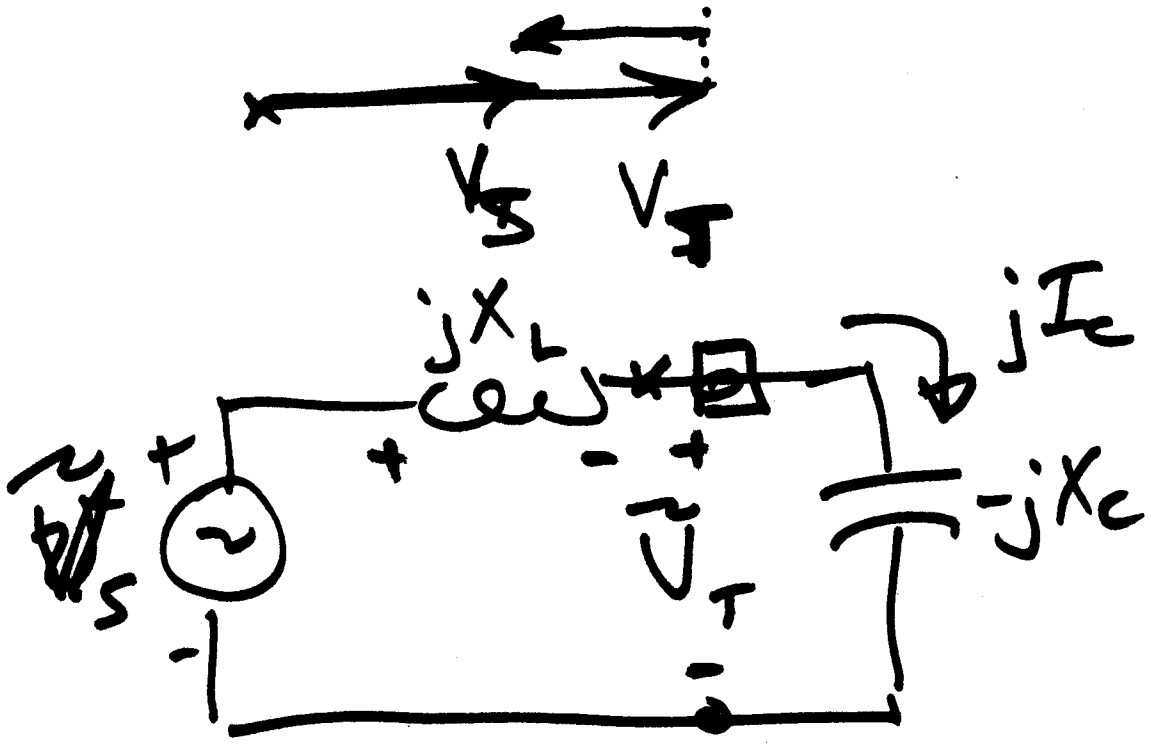
Body of report (number pages 1, 2, 3, ...):
- Introduction (brief overview of project: problem area, motivation, overview of project)
- Background
    - literature search, most important references
    - Presentation of key concepts connected with project
    - Identification of existing voids or weaknesses, 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)
- Conclusions, and Recommendations for Continued Work
- Appendices as required (model details, parameters, complete results, etc)

Supplemental Information:
- Reference List (IEEE format, number [1], [2], etc, in order of first author's last name)
- Use IEEE writing guidelines, abbreviations, etc. Document full details in Appendices.

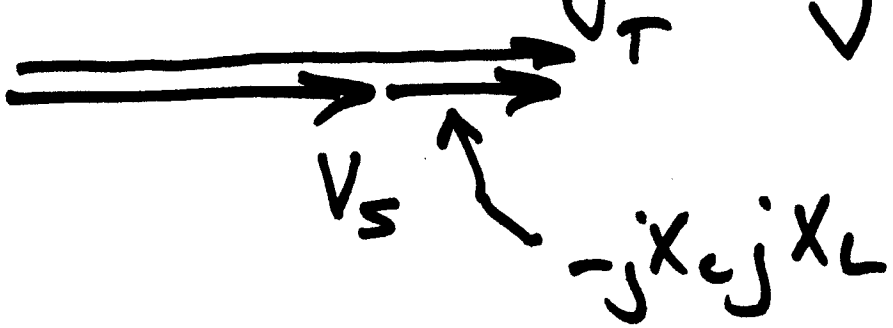
Required layout:
- Font: 11-pt CG Times w/1.25-1.5 line spacing; or 10-pt comic or ariel w/1.0-1.25 line space
- Page layout: 1" margins, include page numbering within margin area.

5.3

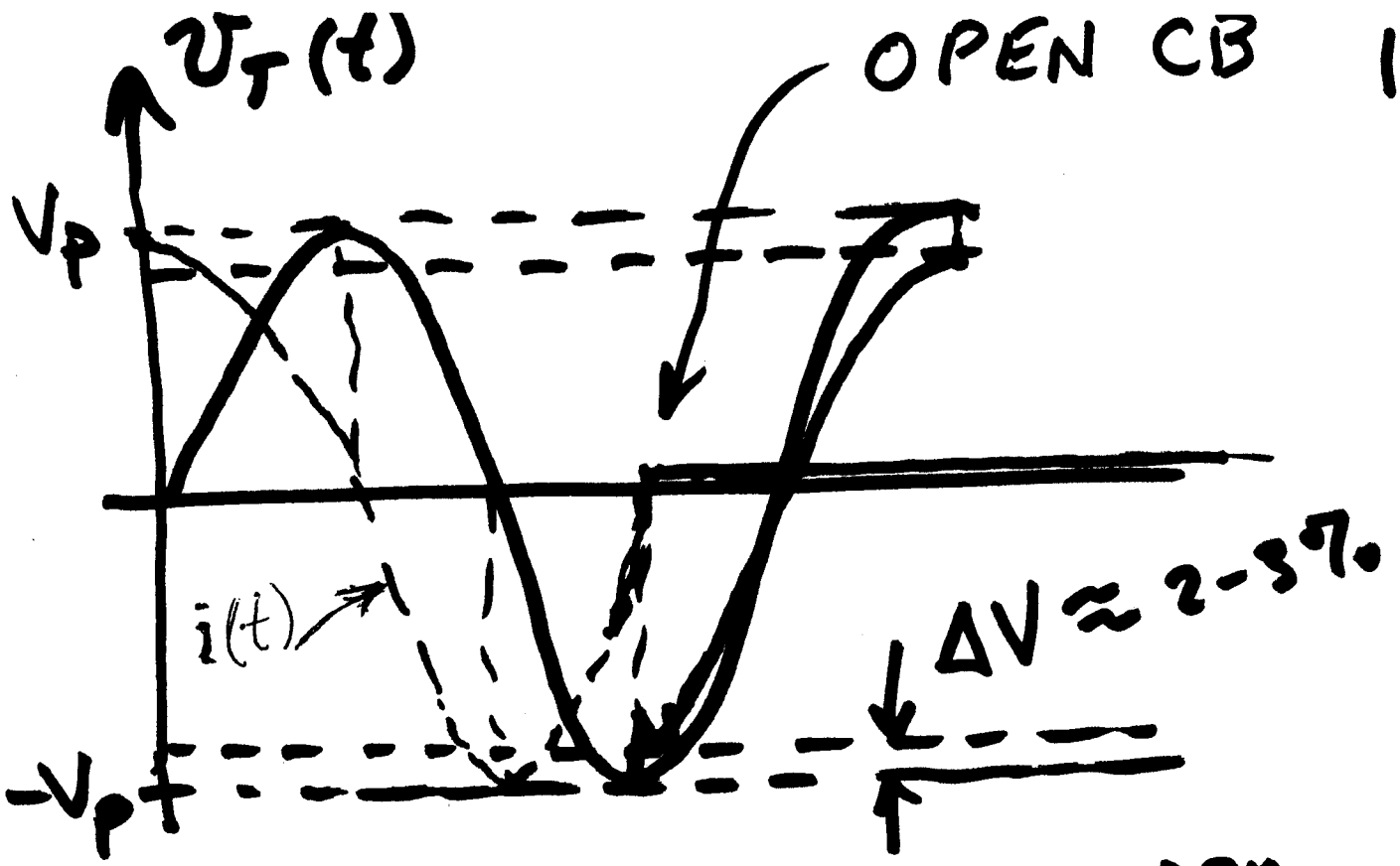


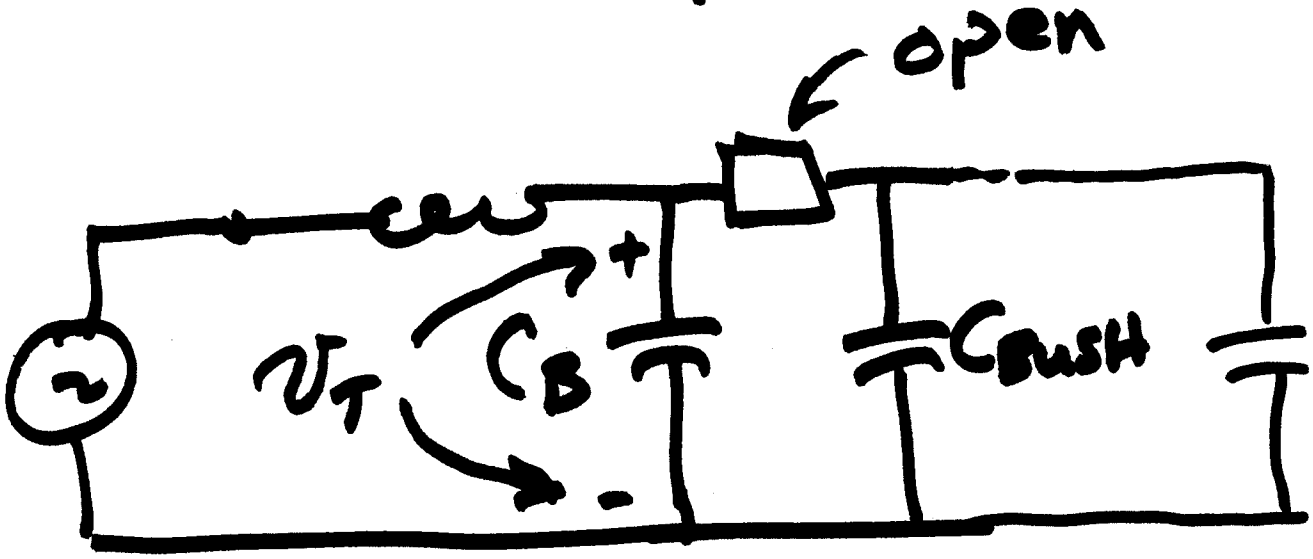


$$\tilde{V}_T = V_S - \underbrace{(jI_c)(jX_L)}_{\text{increase in } V_T}$$



∴ V_T on source side drops when CB opens.


$v_T(t)$
OPEN CB
V_p
$-V_p$
$i(t)$
$\Delta V \approx 2\text{-}3\%$


open
v_T
C_B
+
-
C_{BUSH}

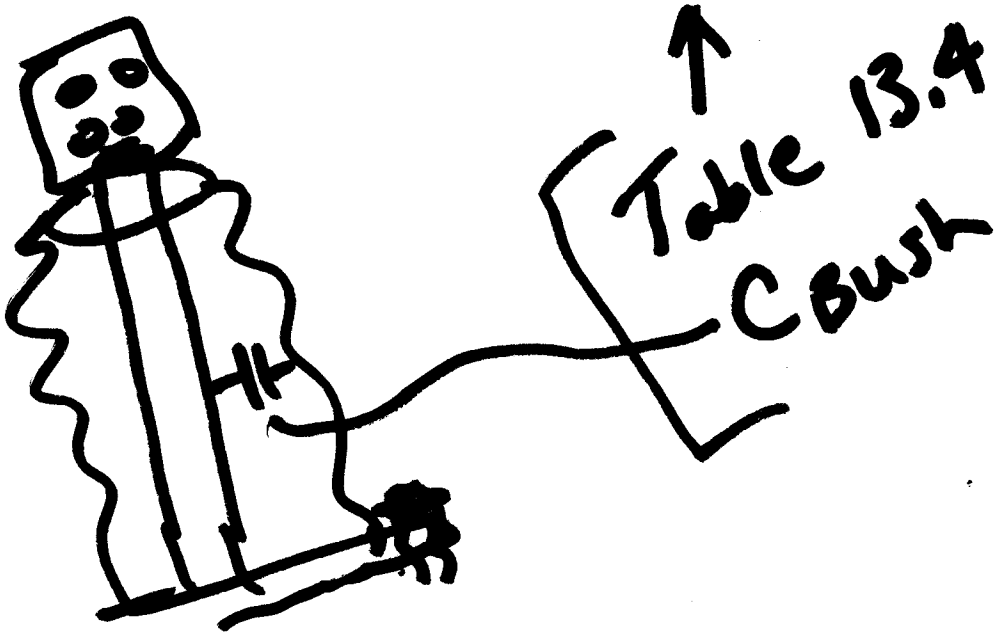
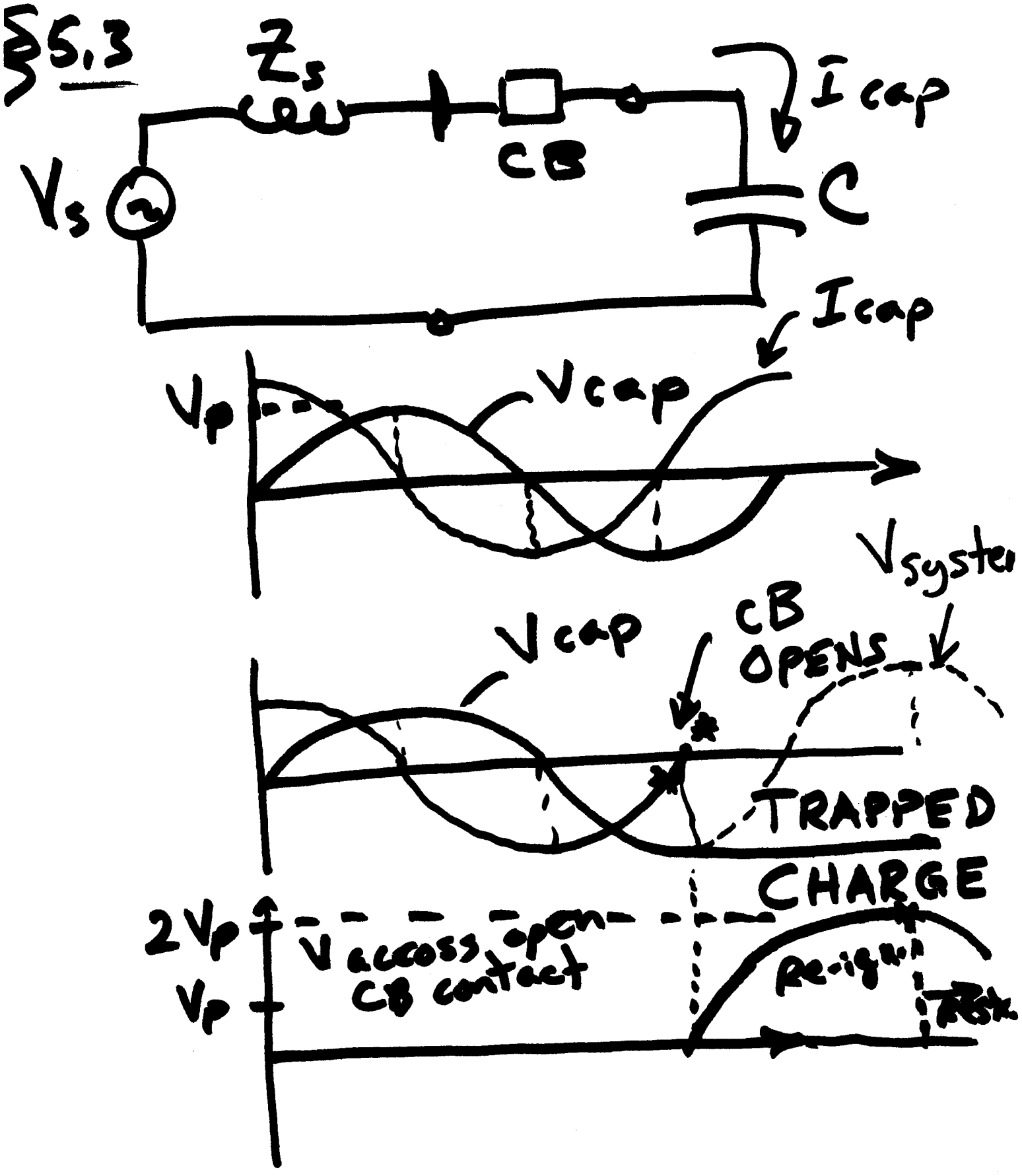


Table 13.4
C_{BUSH}

CAP BANK CB Application 11

§5.3

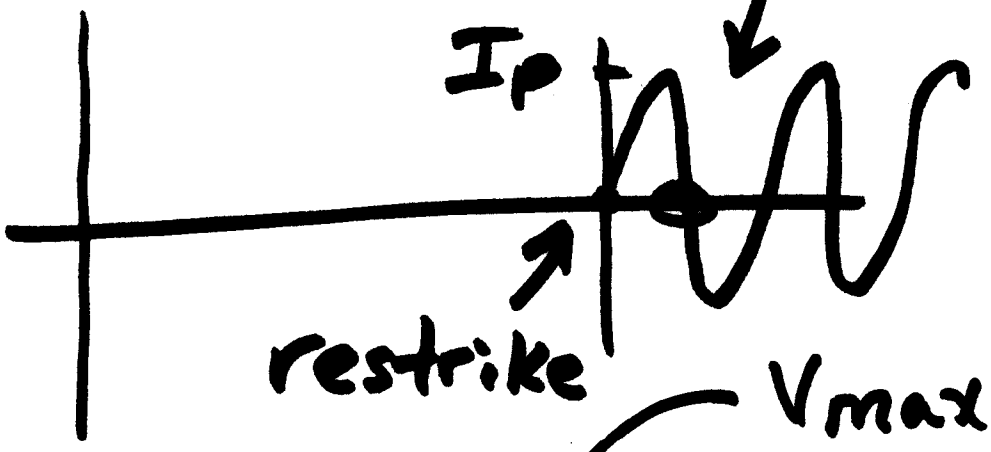


Restrike - Breakdown later than ½ cycle.

Reignition - Breakdown less than ½ cycle.

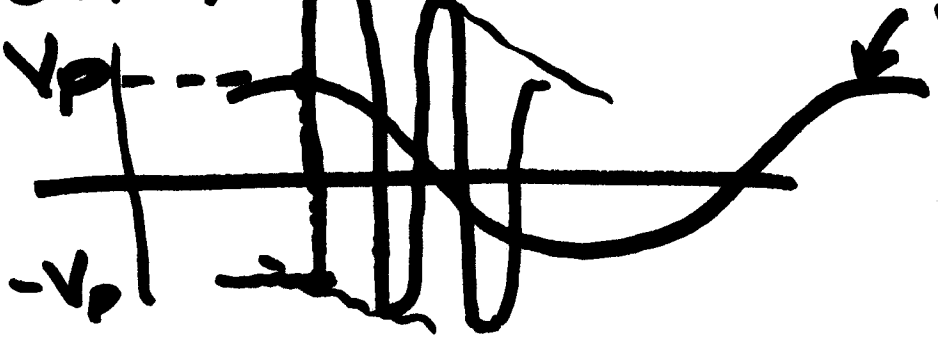
Simulate Restrike at ½ cycle

$$I_p = \frac{2V_p}{\sqrt{\frac{L}{C}}} \qquad f_o = \frac{1}{2\pi\sqrt{LC}}$$



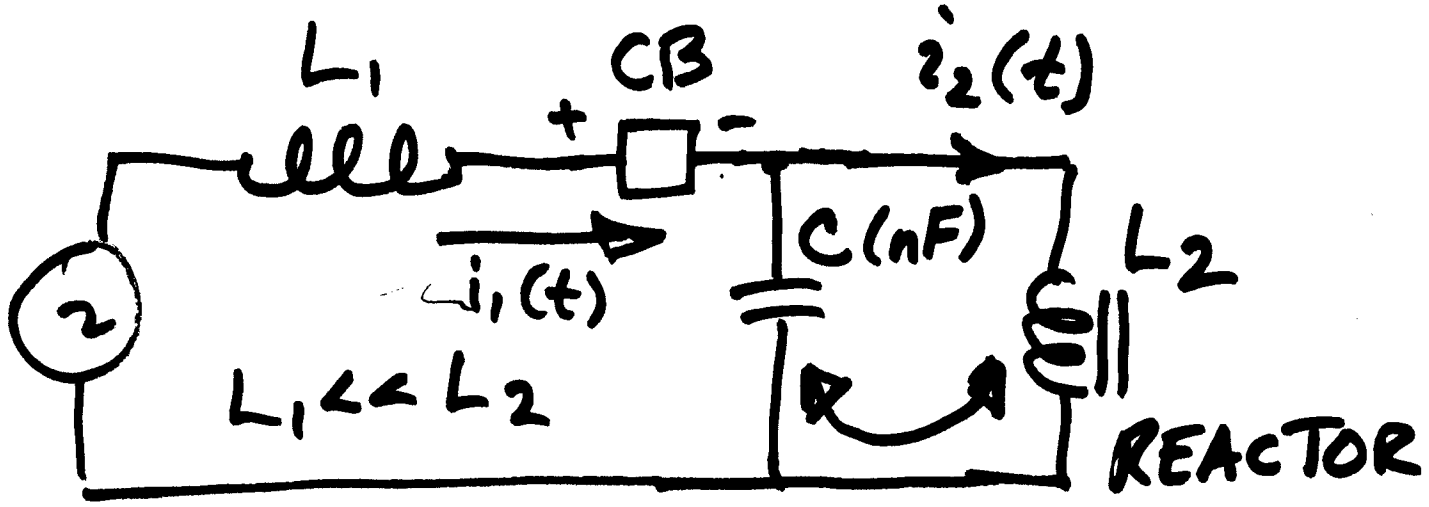
$V_{max} = 3V_p$

Next: On first breakdown,



Reactor Switching (other Restrikes)

Imax



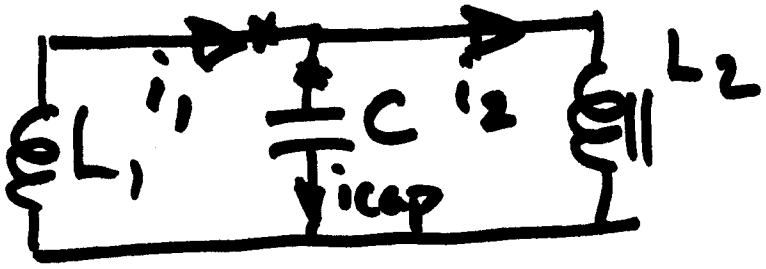
Consider Opening of CB:

- Energy Trapped in L_2 oscillates with C.

Series L_2C resonance

$$\omega_{01} = \frac{1}{\sqrt{L_2 C}}$$ (in KHz range)

If (when?) a restrike occurs?



$$\omega_{o2} = \frac{1}{\sqrt{\frac{L_1 L_2}{L_1+L_2} C}}$$

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

$$i_1 \cong i_2 \cong \frac{V_p(0)}{L_1+L_2} t$$

$$i_1 \cong \frac{L_2}{L_1+L_2} i_{cap}$$