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 = min half letter grade)

- HW#9 - Probs. 9.2, 9.3, 9.4 due Mon Mar 28, 9am.
- Mid-term: Apr 6-11th time window.
- Term Project - choose key journal paper, begin review of journal paper.
- Transformer modeling - Section 11.1 of text, plus lecture notes
  - Magnetic materials: B-H characteristics
  - Transformer Inrush - initial conditions
    - Energization inrush
    - Recovery inrush
    - Sympathetic inrush
- Next - take stock of available ATP transformer models
ATP Pointers: Surge sources

The type 15 surge source is quite adaptable. For example, in Prob. 9.3, you need a surge voltage \( v(t) = 800 \, e^{-25,000t} \). However, the surge function is a double exponential, so how can you use it? Answer: \( v(t) = 800 \, (e^{-25,000t} - e^{-1E12t}) \) Volts, i.e. make \( B \) a really really big negative number and the second exponential will decay almost instantly (during the first integration timestep) and from a practical point of view have no effect.

Important note: \( B \) is by default limited (by a data input filter) to min value of \(-1E6\). Click on Edit definitions button, and change min allowable value of \( B \) to \(-1E12\).
\[
\frac{V_{\text{peak}}}{w} = \frac{\sqrt{2} V}{377} = \frac{169}{377} = 0.45 \text{ unit}
\]
Energization Inrush

Recovery Inrush

$V$ at transformer, drops greatly during fault, $V$ jumps back up to normal very rapidly.

Like inrush, but from a depressed $V$ up to normal $V$. 
Symathetic Inrush -

Close CB3. Inrush to T2 causes a voltage drop at bus. Voltage to T1 is depressed due to inrush to T2. V at bus "slowly" recovers and there can be a mild inrush to T1.
$i_{\text{from SRC}}$  \hspace{2cm} \text{Total Current from source}

$2^{nd}$ harmonic