ECE 524
TRANSIENTS IN
POWER SYSTEMS
SESSION no. 2
\[ \Delta V = L \frac{di}{dt} = L \frac{\Delta i}{\Delta t} = L \frac{2A}{2 \text{ns}} = 10^4 \text{V} \]

\[ X_m = 3770 \Omega \]

\[ L_m = 10 \mu \text{H} \]

If Vacuum Breaker

Older breaker could chop current

2-490 of I\text{rated}

Approx. 10's to 100's mF

10X \frac{x_{m1}}{x_m}

\( I_{st} \) to 10's W\text{N}
Analyzing Transients

- Understand the transient you want to model
- Good data to form detailed models
  » Not trivial to get
- Need mathematical model of the system
  » Appropriate for the transient you are studying
  » Classification of transient important first step

Classifications of Transients

- By Cause
  » Switching transients (all manner of transients)
  » Lightning transients
  » Faults
- Mode of generation of transients
  » Electromechanical
    - Rotating machines mechanical to electrical
  » Electromagnetic
    - Capacitors/Inductors

Introduction 3
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Classification by Frequency Range (CIGRE WG 33.02)

- Low frequency oscillations
  » 0.1 Hz – 3 kHz
- Slow front surges (most switching)
  » 50/60 Hz – 20 kHz
- Fast front surges (lightning, some classes breakers)
  » 10 kHz – 3 MHz
- Very fast front surges (disconnecter restrikes, GIS)
  » 100 kHz – 50 MHz

Validation of Models...

- Graphical user interfaces have made transients programs much easier to use
- It is very easy to get simulation results
- But it is critical to be able to verify that the results are correct
- First step is validating the system model