Use of PSCAD-EMTDC in Power Systems Education and Research

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Electromagnetic Transient Simulation Tools

- Model the power system in extreme detail
- Show most of the second order effects often ignored in other approaches
- Computationally intensive- can be slow if system size is large
- Can be Off-line or Real time
- Examples: EMTP, PSCAD/EMTDC, SIMULINK PS Blockset, etc.

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Releveance in Power Systems Education

- Ability to model various power system devices and systems
  - Transmission Lines and Cables
  - Machines
  - Power Electronics
  - Controls
  - …etc,
- Waveforms Obtained are realistic

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Relevance in Education

- Plays the role of a 'Digital Laboratory' against which other tools and methods can be benchmarked
- Students can see for themselves how the simplified models agree with the 'real thing'
- Ex: S/C Test on Machine

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Ex 2. Construction of the Circuit

- Drag and Drop Entry
- Selection of timestep:
  - Small enough to Meet Sampling Requirements for Signal Reconstruction
  - Much Smaller than Smallest time constant or natural oscillation period in circuit
- Adding Measurement Components

Ex 3. Transmission Lines

- Obtaining Parameters of the Line
- Long-line correction
- Obtaining Pi-Section Model
- P and Q as a function of line angle
  - Surge impedance loading-physical meaning

Ex 6. HVDC Transmission

- Rectification and Inversion Process
- Transmission of Power using Converters
- Harmonics and Harmonic Reduction

Ex 7. Power Quality

- Distorted Waveforms due Power Electronics in Consumer Electronics
- Calculation of Harmonic Distortion

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Ex. 8 S/C test on Machine

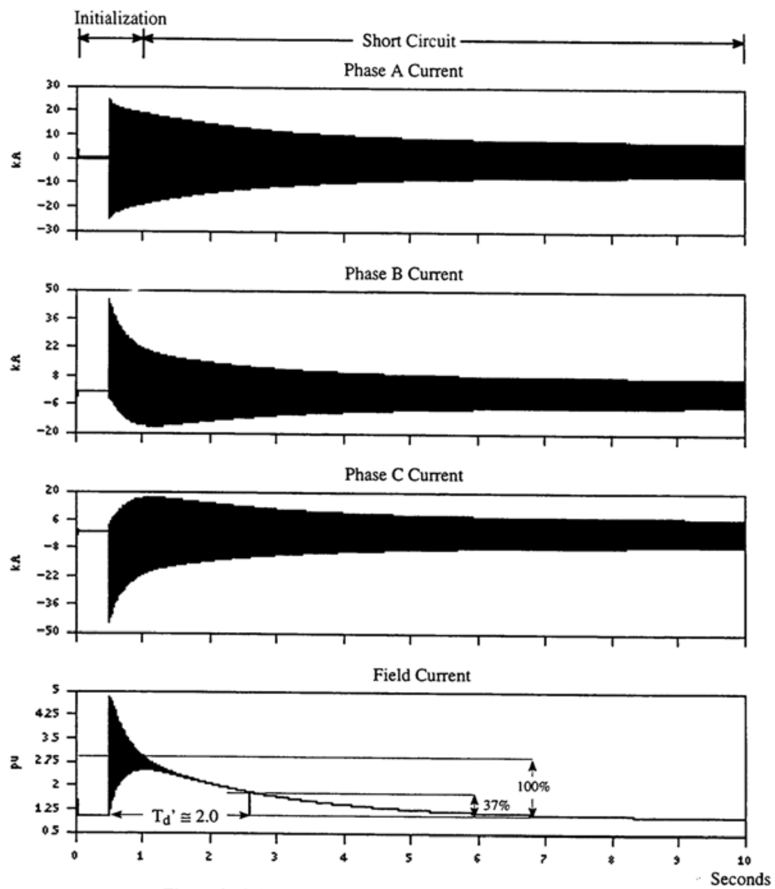

Figure 6.16: System of Example 1 – Shot circuit test results

$$T_d'' = \left(\frac{X''_d}{X_d'}\right) \cdot T''_{d0} = \left(\frac{0.280}{0.314}\right) \cdot 0.039 \text{ s} = 34.7 \text{ ms.}$$

Thus, the sub–transient component can be seen only for the first 1 or 2 cycles as seen from the phase A current in Figure 6.16 and Figure 6.17.

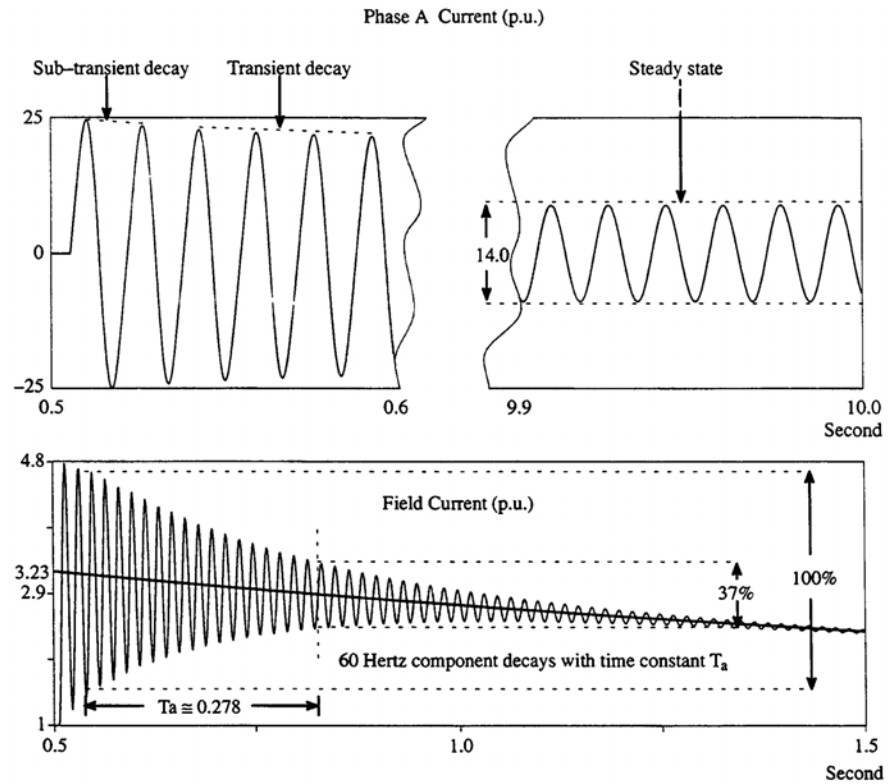

Figure 6.17: System of Example 1 – Short circuit test results (detailed)

Similarly, the transient component should decay with the transient time constant (T_d'):

$$T_d' = \left(\frac{X'_d}{X_d}\right) \cdot T'_{d0} = \left(\frac{0.314}{1.014}\right) \cdot 6.55 \text{ s} = 2.03 \text{ s}$$

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Ex 9. TCR

- Control of shunt impedance using power electronic switch for rapid control of reactive power
- Electronic voltage regulation in large power networks

Ex 13. Line Energization and Switching OV

- Line Energization by non-symmetrical breaker closing
- Point on wave of switching affects the overvoltage
- Use of ZnO arrestors for voltage reduction