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Seminar Announcement

An Overview of Computer Simulation Methods for Electromagnetic Transients in Power Systems

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Until the mid-1960's, the tools for studying electromagnetic transients in power systems were transient network analyzers (TNA's), where Π-circuits with resistors, coils and capacitors represented transmission lines, etc. They were only available in a few places, with a concentration of experts for their operation and interpretation of results. As "EMTP-type" digital computer programs became more readily available, first on mainframe computers, and finally on personal computers, new digital solution methods had to be developed. Per-unit quantities were replaced by actual quantities, though there are still discussions about the pros and cons of both. Symmetrical components gave way to multiphase representations with phase quantities, though transformations to other reference frames are still used for machine and transmission line models. This presentation discusses some of the modelling techniques used in EMTP-type programs.

For synchronous machines, the d,q,0-reference frame is mostly used, though suggestions for working in phase quantities have been made. Transformer models can be as simple as the usual textbook T-circuit model, or more complicated with detailed representations for hysteresis, eddy current and high frequency stray capacitance effects. Sometimes reasonable answers can be obtained with simpler saturation models, as in cases of inrush currents or ferroresonance.

For overhead transmission lines and underground cables, the TNA approach of using cascade connections of Π-circuits has been replaced by travelling wave solution methods. These methods use line parameters that are either constant or frequency-dependent. The line can either be "balanced" (perfectly transposed), or untransposed. For untransposed lines, transformations from phase to "modal" quantities are often used. For adjacent lines on the same right-of-way, these transformations are not easy. This is where the simpler Π-circuit models are still useful, at least for steady-state or low frequency coupling effects.

Circuit breaker models for arc extinction and re-ignition are available, but obtaining the necessary parameters remains a challenge. For power electronics studies, the fixed step size becomes a problem. It can be overcome to some extent by interpolation, and restarting possibly with the same step size at the interpolation point. Restarting is often done with variations of the backward Euler method over one or more time steps. This method also eliminates numerical oscillations that can appear with the trapezoidal rule of integration.

Real-time simulators based on EMTP-type algorithms have become a reality. Utmost speed is needed for the computation itself and for the communication among processors working in parallel.

From an educational standpoint, it is encouraging to see more and more books that cover the computational aspects very well. Continuing education short courses have also helped to educate practicing engineers as well as students in the use of EMTP-type programs. Professional societies such as IEEE have been useful in collecting advice for program users. Lastly, User Groups for commercial software fill the need for sharing information among users spread out in many places.