

EMTP-RV

ElectroMagnetic Transients Program



TRAINING DUBROVNIK, CROATIA - APRIL, 27 - 29 2009

SIMULATION & ANALYSIS OF POWER SYSTEM TRANSIENTS WITH EMTP- RV

Instructors

Sébastien DENNETIERE
Electricité de France, France

Sébastien Dennetière graduated from Ecole Supérieure d'Electricité (Supélec) in France in 2002. He received the M.A.Sc. degree from Ecole Polytechnique de Montréal in 2003. From 2002 to 2004 he worked at IREQ (Hydro-Québec) on research and development activities related to the simulation and analysis of electromagnetic transients. In October 2004 he joined the research center of EDF where his interests are currently in the field of insulation coordination and power system simulations.

Course contents :

Theoretical background on simulation of transients in power systems with EMTP-RV :

- Typical cases of transient studies,
- Computational methods : load flow, steady state, frequency scan, and time-domain simulations,
- Fundamental notions on transients in power systems,
- How to use EMTPWorks (graphical user interface of EMTP-Rv).

Transformers and transients phenomena :

- Basic modelling requirements, which model for which type of study,
- Study of energization of power transformers, harmonic temporary overvoltages, controlled switching

Stephan PACK
Graz University of Technology, Austria

Stephan Pack was born in Graz in Austria and studied Electrical Power Engineering at the Graz University of Technology. Since 1985 he is working with the Institute of High Voltage Engineering and System Management. He is also involved in the work of the Test Laboratory at this University. In 1997 he became an associate professor in the field of high voltage engineering and is nowadays the vice head of the Institute. Additionally he is the head of the group "high voltage techniques" and therefore his work is related to the field of high voltage engineering, high voltage tests, insulation coordination, transients, numerical calculations, lightning and grounding.

For many years he has been member of the national standard organization for lightning, he has been active in a WG in IEC and National Delegate for Austria in CIGRE for System Technical Performance.

Course contents :

Insulation coordination study in a mixed overhead-cable network configuration :

- Investigation of a 110 kV network with EMTP-Rv,
- Analysis according insulation coordination rules,
- Study of several different network configurations and switching states within a mixture of overhead lines and cable sections,
- Analysis of transient lightning overvoltage trends and peak values as well as the transient stress at various network nodes.

Salih SADOVIC
SADOVIC Consultant, France

Salih Sadovic is University professor and international consultant. His research interests include overvoltages and insulation coordination, power systems analysis, numerical field computations and computer applications in power engineering. He is a member of IEEE, SEE and CIGRE.

Tarik SADOVIC
SADOVIC Consultant, France

Tarik Sadovic is research and development engineer at Sadovic Consultant, France. He is doctor student at TU Graz. His fields of interest cover: electromagnetic transients, computer control and measurement, real time remote measurement of the fast electromagnetic transients, overvoltages and insulation coordination.

Course contents :

Transmission line lightning performance :

Basic definitions. Number of strokes collected by OHL. Shielding failures and back flashovers. Critical currents. EMTP modeling for OHL lightning performance calculations: stroke distributions, tower footing resistance, line insulation, tower model, power frequency voltage, corona. How to improve line lightning performance? Line surge arresters. Case study.

HV substation lightning overvoltages insulation coordination :

Basic principles of HV substation insulation coordination. Substation equipment EMTP modeling: surge arresters, power and measuring transformers, breakers, switches, post insulators, bus bars.. Designing incoming overvoltage surge. IEEE and IEC recommended insulation coordination procedures. Cable connected HV substations. Gas insulated substations. Case study.

Switching overvoltages :

Transmission line switching overvoltages. Phase to ground and phase to phase overvoltages. EMTP modeling: source side, line models, surge arresters, closing resistor, statistical switch... Line closing and re-closing overvoltages. Fault overvoltages. Risk of failure calculation. Case study.

EMTP insulation coordination user interfaces :

Automatic creation of "net" files. Running EMTP in loop. Automatic creation of line, arrester and cable models. Running EMTP statistical studies. Automatic calculations of insulation risk of failures.



Electromagnetic Transients Program Application Guide

Camilla Rothe



Electromagnetic Transients Program Application Guide:

Electromagnetic Transients Program (EMTP) S. F. Mauser, T. E. McDermott, Westinghouse Electric Corporation, Electric Power Research Institute, 1986 *Electromagnetic Transients Program (emtp) Version 2.0* V. Brandwajn, Y. Liu, ABB Systems Control Company, Inc, 1991 **Transient Analysis of Power Systems** Juan A. Martinez-Velasco, 2020-02-10 A hands on

introduction to advanced applications of power system transients with practical examples Transient Analysis of Power Systems A Practical Approach offers an authoritative guide to the traditional capabilities and the new software and hardware approaches that can be used to carry out transient studies and make possible new and more complex research The book explores a wide range of topics from an introduction to the subject to a review of the many advanced applications involving the creation of custom made models and tools and the application of multicore environments for advanced studies The authors cover the general aspects of the transient analysis such as modelling guidelines solution techniques and capabilities of a transient tool The book also explores the usual application of a transient tool including over voltages power quality studies and simulation of power electronics devices In addition it contains an introduction to the transient analysis using the ATP All the studies are supported by practical examples and simulation results This important book Summarises modelling guidelines and solution techniques used in transient analysis of power systems Provides a collection of practical examples with a detailed introduction and a discussion of results Includes a collection of case studies that illustrate how a simulation tool can be used for building environments that can be applied to both analysis and design of power systems Offers guidelines for building custom made models and libraries of modules supported by some practical examples Facilitates application of a transients tool to fields hardly covered with other time domain simulation tools Includes a companion website with data input files of examples presented case studies and power point presentations used to support cases studies Written for EMTP users electrical engineers Transient Analysis of Power Systems is a hands on and practical guide to advanced applications of power system transients that includes a range of practical examples **Switching in Electrical**

Transmission and Distribution Systems René Smeets, Lou van der Sluis, Mirsad Kapetanovic, David F. Peelo, Anton Janssen, 2015-01-05 Switching in Electrical Transmission and Distribution Systems presents the issues and technological solutions associated with switching in power systems from medium to ultra high voltage The book systematically discusses the electrical aspects of switching details the way load and fault currents are interrupted the impact of fault currents and compares switching equipment in particular circuit breakers The authors also explain all examples of practical switching phenomena by examining real measurements from switching tests Other highlights include up to date commentary on new developments in transmission and distribution technology such as ultra high voltage systems vacuum switchgear for high voltage generator circuit breakers distributed generation DC interruption aspects of cable systems disconnecter switching very fast transients and circuit breaker reliability studies Key features Summarises the issues and technological solutions

associated with the switching of currents in transmission and distribution systems Introduces and explains recent developments such as vacuum switchgear for transmission systems SF6 environmental consequences and alternatives and circuit breaker testing Provides practical guidance on how to deal with unacceptable switching transients Details the worldwide IEC International Electrotechnical Commission standards on switching equipment illustrating current circuit breaker applications Features many figures and tables originating from full power tests and established training courses or from measurements in real networks Focuses on practical and application issues relevant to practicing engineers Essential reading for electrical engineers utility engineers power system application engineers consultants and power systems asset managers postgraduates and final year power system undergraduates

An Introductory Guide to EC Competition Law and Practice Valentine Korah, 1994 *Energy Research Abstracts*, 1987 **Proceedings of the American Power Conference**, 1999 Practical Applications of ANSI/IEEE Standard 80-1986, IEEE Guide for Safety, 1986 *Transients in Electrical Systems: Analysis, Recognition, and Mitigation* J. C. Das, 2010-05-06

Detect and Mitigate Transients in Electrical Systems This practical guide explains how to identify the origin of disturbances in electrical systems and analyze them for effective mitigation and control Transients in Electrical Systems considers all transient frequencies ranging from 0.1 Hz to 50 MHz and discusses transmission line and cable modeling as well as frequency dependent behavior Results of EMTP simulations solved examples and detailed equations are included in this comprehensive resource Transients in Electrical Systems covers Transients in lumped circuits Control systems Lightning strokes shielding and backflashovers Transients of shunt capacitor banks Switching transients and temporary overvoltages Current interruption in AC circuits Symmetrical and unsymmetrical short circuit currents Transient behavior of synchronous generators induction and synchronous motors and transformers Power electronic equipment Flicker bus transfer and torsional vibrations Insulation coordination Gas insulated substations Transients in low voltage and grounding systems Surge arresters DC systems short circuits distributions and HVDC Smart grids and wind power generation

Dynamic Simulation of Electric Machinery Chee-Mun Ong, 1998 This book and its accompanying CD ROM offer a complete treatment from background theory and models to implementation and verification techniques for simulations and linear analysis of frequently studied machine systems Every chapter of Dynamic Simulation of Electric Machinery includes exercises and projects that can be explored using the accompanying software A full chapter is devoted to the use of MATLAB and SIMULINK and an appendix provides a convenient overview of key numerical methods used Dynamic Simulation of Electric Machinery provides professional engineers and students with a complete toolkit for modeling and analyzing power systems on their desktop computers

EPRI Guide, 1983 **A Directory of Computer Software Applications**, 1978 Electrical Transients in Power Systems Allan Greenwood, 1991-04-18 The principles of the First Edition to teach students and engineers the fundamentals of electrical transients and equip them with the skills to recognize and solve transient problems in power networks and components also guide this Second Edition While the text

continues to stress the physical aspects of the phenomena involved in these problems it also broadens and updates the computational treatment of transients. Necessarily two new chapters address the subject of modeling and models for most types of equipment are discussed. The adequacy of the models, their validation and the relationship between model and the physical entity it represents are also examined. There are now chapters devoted entirely to isolation coordination and protection reflecting the revolution that metal oxide surge arresters have caused in the power industry. Features additional and more complete illustrative material, figures, diagrams and worked examples. An entirely new chapter of case studies demonstrates modeling and computational techniques as they have been applied by engineers to specific problems. A Directory of Computer Software Applications--electrical and Electronics Engineering, 1970-Sept. 1978 United States. National Technical Information Service, 1978. **A Directory of Computer Software Applications, Electrical & Electronics Engineering** United States. National Technical Information Service, 1978. Peterson's Guide to Graduate Programs in Engineering and Applied Sciences, 1978. **A Directory of Computer Software Applications** United States. National Technical Information Service, 1978. *Utility Scale Solar Forecasting, Analysis and Modeling* Kay Stefferud, 2017. Electromagnetic transients program (EMTP) primer Westinghouse Electric Corporation (Empresa Comercial, 1985. **Conference Proceedings**, 1991.

Unveiling the Power of Verbal Artistry: An Psychological Sojourn through **Electromagnetic Transients Program Application Guide**

In a world inundated with screens and the cacophony of instant conversation, the profound energy and psychological resonance of verbal artistry often diminish into obscurity, eclipsed by the constant onslaught of noise and distractions. However, located within the lyrical pages of **Electromagnetic Transients Program Application Guide**, a charming function of fictional elegance that pulses with organic thoughts, lies an unforgettable trip waiting to be embarked upon. Composed by way of a virtuoso wordsmith, this enchanting opus courses viewers on an emotional odyssey, gently revealing the latent possible and profound influence stuck within the elaborate internet of language. Within the heart-wrenching expanse of the evocative examination, we shall embark upon an introspective exploration of the book is key themes, dissect its fascinating publishing style, and immerse ourselves in the indelible impression it leaves upon the depths of readers souls.

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web diagram indicating kinetochore microtubules bound to kinetochores and the aster the aster is an array of microtubules that radiates out from the centrosome towards the cell edge diagram also indicates the centromere region of a chromosome the narrow waist where the two sister chromatids are most tightly connected and the kinetochore a

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web during mitosis two identical copies of the genome are packaged into chromosomes that are distributed equally between two daughter nuclei by a highly dynamic spindle structure

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web the mitotic phase also known as m phase is a multistep process during which the duplicated chromosomes are aligned separated and move into two new identical daughter cells the first portion of the mitotic phase is called karyokinesis or nuclear division

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web the daughter cells are clones of each other every base pair of their is identical the stages of the cell cycle are the stages of mitosis are prophase metaphase anaphase

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web specifically compare the chromosomes in cells at the end of mitosis vs the end of meiosis i recognizing that the diagram of mitosis tracks just a single pair of homologous chromosomes whereas the diagram of meiosis tracks two pairs of homologous chromosomes one long chromosome and short chromosome

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web prophase prometaphase the cell prepares for mitosis at this stage the chromosomes are not clearly visible the chromosomes pairs of sister chromatids condense and become visible meanwhile the nucleolus and nuclear envelope disappear the centrioles begin moving to opposite ends of the cell and start forming the mitotic spindle metaphase

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mechanism found in single celled species complete answer mitosis is a form of cell division in which two