A Probabilistic Model for Residential Consumer Loads

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Abstract: Five torus-type brushless dc motors, each with a different version of the stator core structure, are analyzed. The first one is a slotless stator core, and the four others have the space between the adjacent coils of stator winding filled with the material made either of iron powder composite or laminated iron. An analysis of the motor performance is based on a three-dimensional (3-D) field motor model as well as on the circuit model of the inverter plus the motor set supplied from the battery. The toothed stator core versions show a significant increase of the average torque and also an increase of torque ripple caused mainly by the rise of cogging torque. The analysis based on the simulation results is backed by measurements carried out on the prototype of slotless stator version of the motor.

Keywords: Brushless rotating machines, permanent magnet motors, dc motor, 3-D magnetic fields, dynamics, modeling.

Preprint Order Number: PE-386EC (03-2002)

Discussion Deadline: August 2002

Motional Time-Harmonic Simulation of Slotted Single-Phase Induction Machines

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Abstract: Considering motional effects in the steady-state finite element simulation of single-phase induction machines inevitably requires a transient approach. The resulting computation time seriously hampers the application of finite elements within technical designs. In this paper, time-harmonic finite element simulation, as commonly applied to a three-phase induction machine model, is enabled also for single-phase motors by decomposing the air gap field in two revolving fields with oppostie direction. The advantages and drawbacks of the novel approach are illustrated by a benchmark model. Issues such as ferromagnetic saturation, external circuit coupling, adaptive mesh refinement, and torque computation are addressed. The method is used to simulate a capacitor start/run motor.

Keywords: Ferromagnetic saturation, finite element method, single-phase induction machine, time-harmonic simulation.

Preprint Order Number: PE-479EC (03-2002)

Discussion Deadline: August 2002

Power Engineering Education

A Capstone Design Project To Meet the Needs of the Changing Power Systems Industry and Satisfy New Accreditation Standards

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Abstract: Currently, two motivators are effecting change in power systems education. First, the industry's transition to a more competitive environment requires changes in the content and pedagogy of power systems education. Second, engineering education as a whole is seeking to modify its curricula to reflect a better balance between science and education in order to better meet the needs of industry. These curricular changes are largely a result of revised ABET accreditation requirements. In response to these changes, new curriculum and analysis tools were developed for a power systems capstone design course. The project integrates market economics and sociopolitical considerations with transient stability analysis and transmission planning. A power systems analysis package and an economic analysis tool were developed for use with this project. Student evaluations of the course in which the project was implemented indicate that the curriculum successfully addresses a broad range of ABET accreditation criteria.

Keywords: Capstone design, engineering education, power system operation, simulation, transient analysis.

Preprint Order Number: PE-534PRS (03-2002)

Discussion Deadline: August 2002

Power System Analysis, Computing, and Economics

Implicitly Constrained Substation Model for State Estimation

de la Villa Jaen, A.; Gomez Exposito, A.

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Abstract: This paper addresses the problem of including detailed substation models in state estimation at the least possible cost. After reviewing existing alternatives, it is shown how Lagrange multipliers associated with topological constraints can be computed easily from an implicit model whose size is slightly larger than that of the conventional bus-branch approach. This allows bad data and topological error processing to be carried out simultaneously.

Keywords: Substation models, generalized state estimators, topology errors.

Preprint Order Number: PE-584PRS (03-2002)

Discussion Deadline: August 2002

Optimality with Hydropower System

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Abstract: This paper studies an electricity producer's long-term optimality in the case of a multireservoir hydropower system. The model solves the optimal production process and trading strategy of electricity and weather derivatives by maximizing the utility from production and terminal water reservoir level. The optimal trading strategy hedges the rainfall and electricity price uncertainties.

Keywords: Hedging, derivatives, hydropower, production optimization.

Preprint Order Number: PE-042PRS (03-2002)

Discussion Deadline: August 2002

A Probabilistic Model for Residential Consumer Loads

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Abstract: A probabilistic model for residential loads is proposed. The model differs from other similar models in that it uses a beta probability distribution function to describe the load uncertainty. It further models the load parameter uncertainty as a bivariate distribution of load current means and standard deviations. By separating the probabilistic load uncertainty and the load parameter uncertainty, the model becomes very useful for the analysis of distribution systems where primarily residential consumers are connected, e.g., electrification projects. The model was tested using a Monte Carlo type simulation, and the results are sufficiently accurate for practical design purposes.

Keywords: Load modeling, probability, power distribution.

Preprint Order Number: PE-506PRS (03-2002)

Discussion Deadline: August 2002

A Comparison of Converter Models for the Derivation of the AC System Harmonic Impedances

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Abstract: The effect of converter impedance is mostly ignored when performing harmonic analysis, as it is complicated to calculate, and a common assumption is that it has minimal effect. This paper compares the use of simplified techniques against a rigorous calculation of the converter impedance and demonstrates their effect on the frequency response of the system.