

data acquisition equipment, and client/server industry-standard computer networking technology. The system allows students to get experience on the realistic operation and control of power systems and exposes them to modern data acquisition and supervisory control (SCADA) equipment and procedures used by the industry.

Keywords: Education, laboratories, EMS, client-server systems, real-time systems, and SCADA systems.

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Discussion Deadline: April 2002

Power Engineering Lab: Electricity Market Simulator

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Abstract: This paper presents a successful lab experience to teach pool-based electricity markets to power engineering students. Students are arranged in groups and assigned, at random, a set of generators. They play the role of power producers and compete against each other with the target of maximizing their own profits. The instructor plays the role of the market operator. A market simulator and a computer communication network make it possible to simulate the actual functioning of a pool-based electricity market. The elements that have made this educational experience successful are described and analyzed. Several case examples are discussed.

Keywords: Power engineering laboratory, electricity markets, power producers, simulation tool.

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Power System Analysis, Computing, and Economics

Optimal Power Flow by Enhanced Genetic Algorithm

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Abstract: This paper presents an enhanced genetic algorithm for the solution of the optimal power flow with both continuous and discrete control variables. The continuous control variables modeled are unit active power outputs and generator-bus voltage magnitudes, while the discrete ones are transformer-tap settings and switchable shunt devices. A number of functional operating constraints, such as branch flow limits, load bus voltage magnitude limits, and generator reactive capabilities are included as penalties in the genetic algorithm fitness function. Advanced and problem-specific operators are introduced in order to enhance the algorithm's efficiency and accuracy. Numerical results on two test systems are presented and compared with results of other approaches.

Keywords: Optimal power flow, genetic algorithms.

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Augmented Rectangular Load Flow Model

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Abstract: This paper presents some improvements to the load flow solution in rectangular coordinates. First, in an attempt to use as linear a model as possible, both the nodal equations and the bus constraints are retained. The Newton-Raphson method is then applied to the enlarged set of equations, written in terms of bus voltages and currents. This scheme, combined with a simple procedure to handle PV buses, leads to a computationally efficient algorithm, particularly advantageous in the presence of zero-injection buses. Experimental results are provided

comparing the performance of the proposed approach with that of the conventional formulation.

Keywords: Load flow, current injections, rectangular coordinates.

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Unbundled Reactive Support Service: Key Characteristics and Dominant Cost Component

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Abstract: In this paper, we present a systematic exposition of generator-provided reactive support as an unbundled ancillary service under open access transmission. We discuss the nature and salient physical characteristics of reactive support and analyze their implications in acquiring var support as one of the ancillary services. The paper provides an analysis of the dominant component in the cost structure of this service. This component is determined from the opportunity costs, which are evaluated from the foregone profits of a generator in making sales in real power markets by providing reactive support instead of real power. We illustrate the combined effects of the voltage set points of the generators and of the generator capability constraints on the transactions in competitive electricity markets, both under normal and contingency operating conditions. We discuss the key role of the grid operator in the provision of the reactive support and the key considerations in the acquisition and pricing of the reactive support service.

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Probabilistic Optimality in Long-Term Energy Sales

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Abstract: This article introduces a graphic methodology that makes it possible to compare over a wide range of probabilities the revenues that a generator obtains using different policies to decide how much energy to sell under long-term contracts and how much on the spot market. Examples are provided based on results for the Colombian Power System.

Keywords: Electric markets policies probabilistic comparison.

Preprint Order Number: PE-081PRS (11-2001)

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A Dictionary and Self-Defining Protocol for Exchanging Power System Information

Power System Analytical Data Working Group

Abstract: The Power System Analytical Data Task Force has been meeting since the early nineties with the objective of developing a data dictionary containing definitions of power system analytical data. A dictionary template has been adopted and work on an initial dictionary is underway. A description of the template and the proposed draft dictionary is the subject of this paper. This paper also proposes a protocol for exchanging information contained in a database that has a defined dictionary. Using a typical power system example, a dictionary is defined, and the use of the proposed protocol is demonstrated.

Keywords: Dynamic data, power flow data, power system data exchange, power system data formats, short circuit data.

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