LINEAR GRAPH THEORETIC MODELLING STUDIES OF LARGE-SCALE POWER SYSTEMS

by

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C E R T I F I C A T E

Certified that the research work "Linear Graph Theoretic Modelling Studies of Large-Scale Power Systems" by C.P.Gupta, has been carried out under my supervision at the Indian Institute of Technology,Delhi and that this work has not been submitted elsewhere for the award of a degree or diploma.

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-C.P.Gupta

A B S T R A C T

The linear graph theoretic power system modelling and simulation studies envisaged in this thesis are intended primarily to achieve the broad objective of developing a highly systematic and viable component-to-system construct for power system technical studies in complex frequency as well as time domain. This objective is realized through the formulation of highly generalized systems technical models which can imbed a variety of considerations of stability studies, fault studies and system operation studies into digital computations of a single integrated dynamical model which itself is amenable to computerized formulation. The organization of the research presentation in this thesis is in terms of six chapters which are briefly as follows.

In Chapter I on Introduction a background of power system planning and technical studies has been presented. In particular the literature on power system model formulation has been surveyed. Also presented are highlights of the linear graph theoretic approach for modelling large-scale systems such as power system. Finally, the chapter briefly outlines the contents of the rest of the thesis.

Chapter II develops a linearized system model in the complex frequency domain for a typical electric energy system through the linear graph theoretic technique of branch formulation employing sub-system-to-system construction philosophy of

large-scale physical systems modelling framework. In the process, linearized models of basic components such as generators, transformers, transmission lines and loads have been formulated and combined with appropriate interconnection constraint equations to develop multi-terminal subassembly representations at various levels. In order to extend the scope of such systems studies further so as to include more realistic and sophisticated situations involving the effects of governing mechanism and automatic voltage regulator, we have also developed a complex frequency domain two port model each for the sub-systems consisting of the governing mechanism of the turbine and voltage regulator.

Chapter III is devoted to formalizing a highly rigorous and systematic procedure for the formulation of a linearized state-space model for a large-scale power system with the desirable property of including only directly measurable terminal variables as state variables. The concept of multi-terminal subassembly representation furnishes an orderly and repetitive subsystem-to-system modelling format for stage-by-stage combination of the linearized state models of individual basic components of power system through their relevant intereconnection constraint structure. Certain empirical stability and simulation studies have been performed in the context of a typical power system under consideration.

Chapter IV addresses itself to the formulation of ahighly general nonlinear state model for a power system on a single phase basis, using once again the concept of multi-terminal subassembly representation and the philosophy of component-to-system construction characterizing the linear graph theoretic physical system modelling framework underlying the research in this thesis. Such a nonlinear system model is eminently suited for investigating severe -phase faults representing either dead short-circuits or short circuits through impedance. A simulation study for a 1-phase dead short circuit at alternator terminals has been empirically implemented under the assumption of a constant applied torque at the shaft and a constant applied voltage across the field terminals.

Chapter V presents the most general nonlinear state model formulation for a true 3-phase representation of the synchronous generator (with neutral grounded through an impedance) as a 6-port device. This model can be utilized for studying symmetrical and asymmetrical (line-to-ground,line-to-line, and double line-to-ground) faults with or without impedance. Since this model is exact in nature, it is also ideally suited for rigorous stability analyses. For the purpose of illustrating the applicability of the model to fault situations a single-line-to-ground fault and a 3 ϕ balanced fault on an unloaded alternator have been studied.

Finally, in Chapter VI, the main contributions of the thesis in the area of modelling and simulation studies of large scale power systems are discussed together with a brief presentation of the scope of further work in the field uncovered by the present research.

Curriculum Vitae

Name: ... Chandrika Prasad Gupta

Place & Date of Birth: January 4,1932 - Baberu, Uttar Pradesh, India.

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Since 1963 Reader,Department of Electrical Engg, Motilal Nehru Regional Engineering College,Allahaba (UP).

1958-1963 Lecturer,Department of Electrical Engg, Banaras Hindu University,Varanasi (UP).

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Professional:

1956-1957 Electrical Supervisor Hirakud Dam Project Orissa.

Training:

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