FACTS - Modelling and Simulation in Power Networks

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The subject of flexible ac transmission systems (FACTS) is receiving considerable interest in recent years. The recent blackouts in many power systems around the world have focused attention in this topic. In response to this interest, this book is another attempt by academia to demystify and and explain the controllers that comprise the topic of FACTS.

The book is a compilation of the work undertaken in the past ten years by Professor Enrique Acha from the University of Glasgow, Scotland and some of his Ph.D. students, who have now returned to their native Mexico in pursuit of their careers.

The book commences with a short introduction to FACTS controllers in Chapter 1. It provides also the *raison d'être* for the book since it becomes necessary to develop new mathematical models for the modelling of power systems with these new electronic controllers. At the same time the writing of new software for power flow analysis with these equipment is needed.

An explanation of the mathematical models is needed. Chapter 2 therefore tackles the important task of building the mathematical models for the most common types of FACTS controllers. First, the controllers based on thyristors (such as SVC and TCSC) are discussed, followed by controllers based on Voltage Source Converters (such as STATCOM and UPFC).

Chapter 3 deals with the modelling of the traditional and mundane transmission system components such as transmission lines, transformers and generators.

Chapter 4 then leads onto the Conventional Power Flow methods. A short description of the Newton-Raphson method is included, and students will find this very useful. A listing of a Matlab code is provided for a five-bus test network which formulates the basis of all work later on in the book. The power flow problem is solved to determine the steady-state complex voltages at all buses in the network, from which the active and reactive power flows in the network are derived.

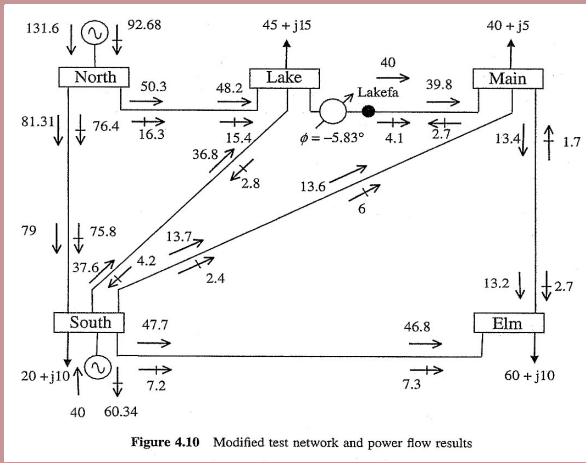
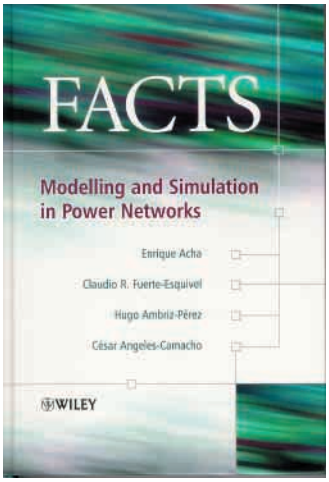


Figure 4.10 Modified test network and power flow results

Chapter 5 discusses the Power flow including FACTS controllers. Amongst the FACTS controllers discussed are SVC, TCSC, STATCOM, UPFC and HVDC-VSC; these are the five most common and significative applications of FACTS controllers. Each controller is modeled with Matlab and the listing of the code is supplied; unfortunately it is not supplied in electronic format which could have been much more practical. Using the benchmark 5 bus network (originally from Stagg and El-Abiad's book published in 1968: Computer Methods in Power System Analysis), each controller application is tested and the power flow results are provided. This was a most useful chapter and highly readable.



Chapter 6 moves from where chapter 5 ended, and the authors provide a three-phase power flow in the phase frame of reference since the study of unbalanced transmission systems is very essential for FACTS controller applications. Again the Matlab code is provided and results are available for comparison cases.

Chapter 7 deals with Optimal Power Flow (OPF) using Newton's method. This is major chapter and deals with representation of the tap changing transformer, phase shifting transformer and all the five major FACTS controllers described earlier.

Chapter 8 is devoted Power Flow tracing. With the new era of deregulation and unbundling of transmission services, a scenario exists where electrical energy trading is performed.

There are a number of Appendices which provide Jacobian elements, Gradient and Hessian elements for OPF and Matlab codes for OPF using Newton's method.

Overall, the book is very well written. Diagrams are generally clear and well laid out. The references are adequate and provided after each chapter. The book is destined to become a classroom text book and will be extremely useful for planning engineers at utilities and consultants alike. My one regret is that the Matlab codes were not also electronically available on a CD-ROM so that the code could have been tested; perhaps the authors or publisher will make a note of that and provide them via the internet to interested readers. I certainly recommend this book to all power system planning engineers and students who wish to follow careers in this area.

Nomenclature:

SVC - Static Var Compensator

TCSC - Thyristor Controlled Series Capacitor

STATCOM - Static Compensator

UPFC - Unified Power Flow Controller

HVDC-VSC - High Voltage DC transmission system based on Voltage Source Converter

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