LOAD FLOW PROGRAM DEVELOPMENT

by

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PREFACE

The purpose of the project reported here was to develop a digital load flow computer program to be used by engineering students who wish to study the behavior of electric-energy systems.

I gratefully acknowledge the help and suggestions received from Professor Floyd W. Harris, my academic advisor. I would also like to thank the Kansas State University Computing Center in helping with the troubleshooting of my program when I could not find the error.

Alan G. Barta

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INTRODUCTION

The purpose of the project reported here was to develop a digital load flow computer program to be used by engineering students who wish to study the behavior of electric energy systems. Digital computer programs of this variety have existed in the industry for a number of years, however none have existed at Kansas State University. With the resurgence of interest in the study of electric energy systems on the part of students and faculty of the College of Engineering, it became apparent that there was a need for a package of digital computer programs that would allow one to study electric energy networks of realistic size. The program developed and reported here is the first such program.

The term load flow studies is used by engineers engaged in the planning, design, and operation of electric energy systems to describe technical studies requiring the solution of the static load flow equations of an electrical network for specified bus conditions.

In its most fundamental form the load flow problem can be stated as follows:

> Given the following information about the network and its equipment
>
> 1. The injected real power at each bus except one (referred to as the swing or slack bus).
> 2. The desired voltage at all buses where there is an active source of reactive power (generator or synchronous condenser).
> 3. Capability limitations on the injected reactive power at the buses where there is an active source of reactive power.

4. The real and reactive demand (load) at every bus.
5. An appropriate model for each transmission line, each transformer (including static tap settings), and each static capacitor/reactor.
6. The bus interconnection scheme.

Determine

1. The injected real power at the slack bus.
2. The injected reactive power at all buses where there is an active source of reactive power.
3. The transmission line real and reactive power flows.
4. The real and reactive power flows through all transformers.
5. The magnitude and phase of all bus voltages.
6. The total system transmission losses.

The digital computer program developed by the author and presented in this report implements this classic form of the load flow problem.

The load flow problem differs from the classic network problem in that the primary objective of the load flow studies is to calculate power flows directly, whereas the primary objective in classic network studies is to calculate voltages and currents directly. This means that the load flow studies require that we solve a set of nonlinear algebraic equations rather than the linear set normally associated with the classic network problem. There is also a more subtle difference. The classic network problem is usually formulated in such a way that either the terminal voltage or terminal current of every energy source is specified, and one is required to calculate the voltages and currents associated with the passive (load) elements. The load flow problem is always formulated in such a way that the product of the current and voltage associated with the load elements is specified, and one is charged with finding the products of source terminal voltages and currents that are necessary to