CHAPTER 1

INTRODUCTION

Prior studies [1,2,3] and Appendix 5 in this thesis have shown that load characteristics can have a significant effect on power system performance. Therefore loads should be represented in a reasonable way. In recent years, several efforts have been made to develop suitable load models.

Individual loads may be divided into two broad classes [2];

- static class
- rotating class

The static class consists of heating and lighting equipment. The rotating class consists of motor with variety torque speed characteristics. There are some other types of industrial loads which are not generally motor loads, such as electric furnances.

When oscillations occur in a power system also static class loads will respond dynamically in power to the variations in voltage and frequency. So, it is possible to have one model explaining the power consumption in all types of loads.

Normally, electric loads have been modelled as constant impedance, constant current, constant power or combination of these [2,4,5]. Many works [1,2,3,6] use exponential models to represent loads, e.g. $P = P_o * V^n$ or $P = P_o * V^n * (1+b * \Delta f)$

In ref.[8] a model which also considers frequency variations is described. It has the form :

$$P = P_o * (V/V_o)^{np} * (f/f_o)^{mp}$$

$$Q = Q_o * (V/V_o)^{nq} * (f/f_o)^{mq}$$

Where the constants can be obtained from experiment measurements or from earlier works.

In fact, constant impedance, constant current and constant power are particular cases of this model. For example, if np = 2 the load is one of constant impedance; if np = 1 the load is one of constant current; and if np = 0 the load is one of constant power.

In some cases (e.g. when motor load is a large portion of the total load) the models described above may be difficult for use in dynamic simulation, because they neglect the dynamic nature of loads. The models have to be extended and composed as polynomials in voltage and frequency.

Most static loads have very small time constants, and are simple to model. However, induction motors differ from other loads due to their inertias and load torque characteristics. Many works [9-16] use induction motor models to represent induction motor load.

In ref.[11] methods of representing induction motors with different degrees of accuracy are presented. Ref.[12-17] present methods for grouping several induction motors into one eqivalent motor.

Another approach for load modelling used in ref. [18] is a state space load model. It is written as :

$$\dot{x} = Ax + Bu$$

$$y = Cx + Du$$

where x is the state vector, u the input vector, and y the output vector. From the two equation, active and reactive power can be calculated.

In ref.[19] a transfer function load model is presented. It has the form :

$$\begin{bmatrix} \Delta P(s) \\ \\ \Delta Q(s) \end{bmatrix} = \begin{bmatrix} K_1*(s+b)*(s+a)/[(s+b)^2+w^2] & K_2*(1+sT_F) \\ \\ K_3 & 0 \end{bmatrix} \begin{bmatrix} \Delta V(s) \\ \\ \Delta F(s) \end{bmatrix}$$

In the above equation, variables and transfer functions are given in terms of the Laplace transformation.

In this thesis, suitable load models for individual and composite loads are derived from knowledge of the end-use components.

Because individual loads have different characteristics, the method selected here is to use models of the different components and then put them together to a composite load.

A computer programme is made for representing steady state and dynamic characteristics of loads due to voltage and frequency variations.

In some cases special formula for load representation have to be used e.g. polynomials in voltage and frequency. In such cases the computer programme can be used for calculation of the parameter values in the formula.