CHAPTER I

INTRODUCTION

The first operating objective of electric power systems is the continuity of service to customers. This is a basic consideration. It requires that generation be match to load. It means that there must be moment - to - moment adjustment of generation to match moment - to - moment changes in customer demand. The accommodation for customer load changes is achieved fundamentally by the governing action, sometimes referred to as the natural responses of the system. Most operating generators are equipped with speed governors. An increase in system load, for example, tends to decrease system speed or frequency. Governors, sensing this decrease in speed, automatically cause the generators to increase output to match the new load. Thus, if enough generators were running on the system, and their governors were appropriately responsive, the natural governing responses of the system would automatically ensure that the total generation was always match to total load.

Frequency Deviation of an Isolated System

Although the customer demand is already supplied by the governing action, the frequency of the system still drops. This is because of the drop characteristic of the speed governor. It is necessary to raise the frequency up to the nominal value. This work is accomplished by a speed changer. The raise command signals from the controller are fed to the speed changer which will force the generator to increase the generation resulting in raising the system frequency to the nominal value. In an interconnected system if a load change occurs in one area the neighboring areas will share that load by the flowing of power through tie lines. Thus, the system frequency does not change so much because of the helps of the other areas in supplying the change of load. This is one advantage of the interconnected system. For the isolated system, of course, there is no such helps, then the system frequency deviation is more than that of the interconnected system. It was shown that the frequency drop in an isolated area when subjected to a step load change is two times that of the two identical interconnected areas for the same load.[5]

Survey on Load - Frequency Control (LFC)

The disturbance caused by load fluctuations in the interconnected system results in changing tie - line power and system frequency. This requires some form of a load frequency control. Generally, the form of load frequency control is based on an error signal which is a linear combination of the net interchange and frequency errors. A simple integral type of control is usually used to drive the error signals to zero.

Modern optimal control theory has led to the development of design techniques which can result in significant improvement in the control of high - order system. Elgerd and Fosha[7] applied this theory to improve the LFC problem of the interconnected system of two areas. This research concerns with the study of controlling the frequency and applying the optimal control theory to improve the frequency response of an isolated power system.

Importance Characteristics of a Power System

It is known that the important characteristics of a power system are as follows :

1. A mistmatch in the real power balance affects primarily the system frequency, but leaves the bus voltage magnitude unaffected.

2. A mistmatch in the reactive power balance affects only the bus voltage magnitude, but leaves the system frequency unaffected.

It should be emphasized that these rules apply only when the changes involve only a small percentage, i.e., first order in mathematical sense. In view of the above facts, the nominal steady state control problem can be divided into two control problems:

1. The megawatt - frequency control problem. By means of a frequency sensor, the frequency error which is the most sensitive indicator of the real power unbalance, is detected. If an error exists, lower or raise commands are sent to prime mover, this should result in an increased or decreased real generated power.

2. The megavar - voltage control problem. By means of a voltage sensor, bus voltage magnitude deviations are detected, they are the most sensitive indicator of the reactive power unbalance. If an error exists, increase or decrease commands are sent to Q sources.

This research concerns with the first problem. It is assumed that bus voltages are constant during load changes. This assumption is based on the principle described above. The assumption is supported by the fact that system voltage regulation is relatively fast compared to the response of the system frequency.

Outline of the Research

In this research, the frequency of an isolated power system is controlled at the nominal frequency (50 H_Z). To do this the dynamic system model representing an isolated power system is presented. Two control strategies are used :

1. Conventional or classical control. In this method, the signal fed to the speed changer is obtained by the multiplication of gain K_I by the integration of the frequency deviation. The frequency deviation is called area control error (ACE). By means of a speed changer, the generation is adjusted until the ACE equal zero. There are two parts in this section. First, a conventional control strategy is applied to control the linearized system model. Second, the same control strategy is applied to control the system with included effects of the speed - governor dead band. Both cases are simulated by an analog computer to study their responses.

2. Optimal control strategy. State variables are introduced and the linearized system model is rewritten in state space form. Optimal control theory is then applied to develop the optimal controller. To obtain the optimal controller it is necessary to solve the Riccati equation. A digital computer program is written for solving this equation. The optimal controller is fed to the speed changer to adjust the generation so that the frequency response is

optimum. The simulation is also performed by an analog computer.

The control processes and the frequency responses obtained from the simulations of the control system using the two control strategies are compared. The control system using the optimal control strategy shows the improvement in system stability and better frequency response.