CHAPTER V

SUMMARY

Discussions

This research begins with a presentation of the standard simplified dynamic model for an isolated system. The governor and turbine generator have been represented by two time constants T_G and T_T. The former represents the time constant of the speed governor, and the latter of the turbine. The generator response is practically instantaneous. The transfer function that represents the turbine generator in the model is based on the non - reheat type of steam turbines having relatively fast response.

The command signal of speed regulation due to governor action is obtained by the multiplication of Δf and $\frac{1}{R}$. The error signal Δf is assumed to be available as a continuous signal. In reality, the measurement of the frequency deviation Δf takes place discontinuously in sampled - data fasion. However, if the sampling rate is relatively high compared with the fastest change in response of Δf, then the analysis gives good results.

The type of the disturbance chosen for the search of controls is a step variation in load. This is probably adequate to qualify the system response to large perturbations, such as loss of a big generator or a suddenly loaded the system. In reality, the load changes in power system are random variations having Poisson distribution or the like. However, it is chosen to base the analysis on a step function type of load change. This is, of course, in accordance with a standard control practice. If one knows how a system performs in response to a step input, which is the simplest of all inputs, he can compute, for the linear system, by superposition the response to any other input. Thus, it can be seen that the step - input response conveys the most compact and meaningful information.

A small change in real power affects primarily the system frequency while system voltage remains fairly constant. Another reason, the response of voltage regulator is relatively fast compared with the frequency response. Thus, the system voltage is assumed constant through out the analysis

The presence of the speed - governor dead band in the conventional control system produces the system oscillation. Both magnitude and period of the oscillation are very sensitive to the value of K_I . Thus, K_I must be selected carefully in order to obtain good response. For better control, the dead band should be minimized.

The optimal control theory known as the state regulator problem is employed to improve the Δf-response. The linearized system model is used for the study. To obtain the optimal controller $\hat{U}$; the cost functional J is defined. Two general comments should be made :

1. Many optimal controller exists; in facts, for a controllable system there will be one for each choice of the cost functional J.

2. These controllers do not necessary satisfy standard engineering judgment other than the one represented by the

minimization of the chosen cost functional.

The method of controlling the system frequency using the conventional control method is a simple one compared to the optimal control method. In the first method the control signal, obtained from the integration of the frequency error, is fed to the speed changer to adjust the power output to match the load changes. In the optimal control method the system must be rewritten in state space form and the controller is not only the function of Δf, but also the function of all states of the system. To obtain this controller it is necessary to solve the nonlinear Riccati equation. There are many methods in solving this equation. In this research, the method developed by Hitz, K.L., and B.D.O. Anderson is used on a digital computer to obtain the solution. Obviously, the optimal control method is more complex than the conventional control method. However, it is felt that the great improvement in dynamic response and system stability justifies its usage.

Conclusions

Based upon the results obtained for the particular isolated system studied, the conclusions may be reached as follows :

1. If there is no signal input to the speed changer, i.e., $\Delta P_C = 0$, the static frequency error will be directly proportional to a step load change and inversely proportional to the AFRC.

2. Any value of K_I greater than zero will, in the end, result in zero static frequency deviation. But, if K_I is greater than, approximately, .8 the system goes unstable.

3. The higher the integral gain K_I the faster the response of Δf is obtained and also the greater tendency to oscillate. The best response is obtained at the value of $K_I = .3$.

4. For a given value of K_I the speed of the Δf-response is constant and independent of the applied load.

5. The presence of the speed - governor dead band causes the system to produce continuous oscillations of low frequency. The integral gain K_I has the great effect on both the magnitude and the period of the oscillations.

6. The higher the integral gain K_I, the larger the magnitude and the shorter the period of the oscillations are obtained. The value of $K_I = .05$ gives the best response.

7. The presence of the speed - governor dead band is equivalent to a broadening of the speed regulation. This requires a reduction in the frequency bias or a reduction of K_I in order to obtain a good response.

8. There is no problem concerning the choice of the values of the integral gain K_I when using the optimal control technique.

9. For an equal load change the magnitude of the frequency deviation of the optimal control method is less than that of the conventional control method, and the response of the former method is more rapid than the latter method.

10. The control process of the optimal control system is not as simple as in the case of the conventional control system.

11. The dynamic response and the system stability are improved in the optimal control system over the conventional control system.