ABSTRACT

Power systems stability is a complex problem which was first recognised in 1920 and has been widely investigated by power system engineers ever since. The first laboratory test on a practical power system was conducted in 1924, followed by the first field test in the following year. The models and method of analysis were relatively simple, with long fault clearing times (0.5 to 2.0 seconds). In 1930, network analysers (which were analogue simulators of the power system) were developed and this led to the improvement of stability analysis. In early 1950's, they were used to analyse problems which required detailed models of the synchronous machine, excitation system and speed governor. In the mid 1950's, the first digital computer program for power systems stability was developed. Since the 1960's most of the industry efforts and interests relating to system stability have been concentrated on transient stability. Power systems are designed and operated to criteria concerning transient stability (Kundur, 1994). There have been significant developments in equipment modelling and testing, for synchronous machines, excitation systems and loads. In addition, using high speed fault clearing, fast exciters and special stability aids have been used to improve the transient stability of power systems. The high speed exciters adversely affect the small signal stability associated with local plant mode of oscillations by introducing negative damping of the rotor angle oscillations. Such problems have been solved using power systems stabilisers (PSS). The incorporation of a power systems stabiliser (PSS) into the excitation controller is to improve the system's performance where the system's damping is low. At the same time, it can also combat the damping reductions introduced by an AVR (Hughes, 1991). The damping of the rotor angle oscillations can be improved by adding a supplementary signal to the excitation control system to produce a component of the electrical torque on the rotor in phase with speed variations (Larsen and Swann, 1981). Figure 5.1 shows the block diagram of a power system stabiliser added to the excitation control system. The rotor angle oscillations of a generator feeding power to a large inter-connected power system occur in the frequency range of 0.2 to 2 Hz. Different signals have been used as the input to the PSS including: the rotor speed deviation, the bus frequency, the electrical power deviation and the accelerating power (Padiyar, 1996). When a speed signal is employed as an input for the PSS, then a phase lead compensator is required to provide sufficient phase lead (Hughes, 1991). A transient gain or washout is normally used to remove any steady state offset in the speed signal. This filter acts as a high pass filter and is required to ensure that the stabilising signal (PSS output) does not affect the steady state regulation characteristics.