Seminar

==========

Institute for Plasma Research

==========

Title: Control Techniques for Frequency Regulation in Hybrid Power Systems

Speaker: Dr. Vivek Patel

Motilal Nehru National Institute of Technology, Allahabad

Date: 04th August 2023 (Friday)

Time: 10.30 AM

Venue: Seminar Hall, IPR

Abstract

The objective of the power system control is to generate and deliver power in a large interconnected system economically and in a reliable manner while maintaining the frequency and voltage within the permissible range. Based on the power system control hierarchical structure, the control scheme consists of different nested loops, which are used to regulate different variables such as frequency, voltage, etc., in the power system. Among the different nested control loops, two control loops play a vital role in the operation and control of the power system. These are automatic voltage regulator (AVR) and load frequency control (LFC), also known as automatic generation control. The AVR is used to control the reactive power and voltage magnitude and LFC is used to control real power and nominal frequency.

A hybrid power system combines conventional and renewable energy power plants. Poor settling times and increased transient in system responses are two major problems caused by integration of conventional and renewable energy. Frequency variation brought on by such interconnection is the main problem of the hybrid power systems. Power system reliability and efficiency are guaranteed by the LFC design.

Most of the power system utilities participate in frequency regulation task with simple, heuristically tuned controllers. The objective of this work to develop advanced control techniques in uncertain power system to achieve both minimum over/undershoot and reduced settling time simultaneously. Furthermore, the controllers designed also exhibit significant reduction in chattering (high frequency oscillation). The issues and proposed directions of this work is to develop following control strategies for frequency regulation of different types of hybrid power system:

- Disturbance observer based second-order sliding mode controller for hybrid power system consist of reheated thermal power plant, wind power generator (WPG), fuel cell, diesel engine generator, and battery energy storage system using salp swarm algorithm.
- Minimum order disturbance observer based fractional-order sliding mode controller for hybrid power system consist of reheated thermal power plant, and WPG .
- Neural network aided fractional-order sliding mode controller and neural network observer based second-order sliding mode controller with harris hawk optimization for nonlinear interconnected power systems with an integration of wind system.
- Super twisting sliding mode controller for time delayed interconnected power systems with redox flow battery.

Optimization algorithm has been adopted for tuning the controller parameters to alleviate the system oscillations and improve system stability in the presence of uncertain perturbations. Stability proof using Lyapunov analysis is shown for the control techniques considered in the work. The efficacy of the approaches presented in this work has been validated through simulation studies.