DESIGNING A ROBUST CONTROLLER TO DAMP SUB-SYNCHRONOUS OSCILLATIONS IN POWER SYSTEMS

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Degree of Master of Science

Department of Electrical Engineering

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July 2020

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science

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DECLARATION

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Dr. W. D. Prasad

ABSTRACT

In the power transmission systems, the power transferring capability is limited due to the inductive reactance of the transmission lines. In order to mitigate the inductive effect, some compensation techniques are applied to the transmission lines. One such technique is the series compensation using capacitor banks. Series compensation method is used to improve the system voltage with capacitor banks are connected in series with the power transmission line and it expands the power transferring capability of the line. Although the increase of series compensation improves the power transfer capability and the steady-state and transient stability limit of the power transmission line, it can lead to the generation of some natural frequencies due to the combination of inductor and capacitor (L-C). These frequencies are called as sub-synchronous frequencies which are below the power frequency of the power systems. They can arise sub-synchronous resonance (SSR).

The SSR can cause physical damages to the power system equipment unless it is detected and mitigated punctually. Several number of mitigation techniques for different types of power system oscillations have been proposed in literature. But existing mechanisms are not completely damp these oscillations or the mechanisms used to damp these oscillations might be source for any other control situations. Therefore, this is a phenomenon which should understand well and damped these oscillations properly. The intension of the work presented in this thesis is to properly mitigate the undamped power system oscillations which are in the range of sub-synchronous frequencies.

This research proposed a robust controller which can damp dominant sub-synchronous resonance. Further, the implemented controller performs well in different operating points. IEEE First Benchmark Model (FBM) is used as the test system and the dynamic phasor representation of the system is used to model the small signal model. The operating points of the test system were generated by changing the series capacitor compensation level of the power transmission line. Finally, this research introduced a robust controller with PID controlling to damp out dominant sub-synchronous oscillations which can perform well under different operating points of the selected power system.

ACKNOWLEDGEMENT

First, my sincere thanks must go to my advisor, Dr. W. D. Prasad for his continuous advice, guidance, encouragement and patience throughout the course of this work. It has been a privilege to work under his guidance. I am also thankful to the course coordinator, Dr. Buddhika Jayasekara and the staff of the Department of Electrical Engineering, University of Moratuwa for their continuous encouragement.

Further, I am thankful to my father and late mother for believed that I can always do better than I believed in myself. A special thank goes to my husband for encouraged me to reach for a successful end.

C.M. Gamage
July 2020
University of Moratuwa.

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AC	Alternating Current
SSR	Sub-Synchronous Resonance
PSS	Power System Stabilizer
AVR	Automatic Voltage Regulator
FACTS	Flexible AC Transmission Systems
HVDC	High-Voltage Direct Current
SVC	Static Var Compensators
STATCOM	Static Synchronous Compensator
SSDC	Sub-Synchronous Damping Controller
TCSC	Thyristor Controlled Series Compensation
IEEE	Institute of Electrical and Electronics Engineers
FBM	First Benchmark Model
SSSC	Static Synchronous Series Compensator
FLC	Fuzzy Logic Control
FFT	Fast Fourier Transform
HP	High Pressure
IP	Intermediate Pressure
LPA	Low Pressure A
LPB	Low Pressure B
SA	Simulated Annealing
VSC	Voltage Sourced Converter