Department of Electrical Engineering
Delhi Technological University
Delhi

CERTIFICATE

This is to certify that **Mr. Nikhil Mundra**, a student of final semester **M.Tech (Power Systems)**, **Electrical Engineering Department**, during the session 2010-2012 has successfully completed the project work on **"Subsynchronous Resonance Mitigation using TCSC"** and has submitted a satisfactory report in partial fulfillment for the award of the degree of **Master of Technology (Power Systems)** in Electrical Engineering Department.

Dr. Suman Bhowmick
Associate Professor, EED
Delhi Technological University
Delhi -110042

ACKNOWLEDGEMENT

It is with immense gratitude that I wish to express my profound gratefulness to my guide, **Dr.Suman Bhowmick,** Associate Professor**,** Electrical Engineering Department, Delhi Technological University for encouraging my interest in the topic and providing me the guidance for the same. The enlightening discussions I have had with him have enhanced my knowledge manifold, and helped me gain a thorough understanding of the subject. His constructive criticism and valuable suggestions throughout this project work have been of great help. His endeavor to provide constant support and supervision has helped me enormously, and I shall forever remain indebted to him for this.

I would like to express my sincere thanks to **Prof. Narendra Kumar,** Head of the Department and other faculty members of the Electrical Engineering Department, Delhi Technological University for providing a conducive environment and facilities to carry out this research work.

I would also like to thank my Family and Friends for being pillars of strength during my course and the completion of this project. Finally, this note would remain incomplete without the mention of God Almighty, who has been watching over me and has showered abundant blessings throughout my life.

Nikhil Mundra

M.Tech (Power Systems)

Roll No. 07/PSY/2K10

ABSTRACT

Sustained oscillation below the fundamental system frequency can be caused by series capacitive compensation. This phenomenon is known as sub synchronous resonance (SSR). The turbine generator mechanical system comprises large masses connected by steel shafts. This rotating system has torsional resonance frequencies at which adjacent masses tend to twist back and forth for any shock. A shock to a turbine generator unit on its own and connected radially to a power system via a series compensated line can cause the turbine generator unit to oscillate at one or more of its modes of torsional oscillations. These oscillations can produce peak torques in the shaft system several times the normal torque corresponding to the rated power. Under some circumstances shaft twisting may become excessive at one of the resonance frequencies and potentially damage the shaft even without any series capacitor compensation.

Traditional techniques to mitigate SSR include the use of Power System Stabilizers (PSS), which have been reported to be moderately effective for this purpose.

In the 1980's, the EPRI initiated the FACTS technology where various power electronics based FACTS devices were used to improve power transmission capability over existing transmission corridors. Subsequently, these devices were increasingly used for improving transient stability and for SSR mitigation. In particular, series FACTS Controllers can actively mitigate sub synchronous resonance either by their non-capacitive characteristics in the sub synchronous frequency range of interest or by active damping action. This consists of thyristor modulated series compensator like TCSC where control of sub synchronous oscillations is achieved by modulating the thyristor switch firing angles using various signals such as generator shaft speed, line current, etc.

In this project, the phenomenon of SSR is first demonstrated in the IEEE first benchmark model and is subsequently mitigated using PSS and thyristor controlled series capacitor (TCSC).

LIST OF ABBREVIATIONS

FACTS	Flexible Alternating Current Transmission Systems
IMDU	Induction Machine Damping Unit
IPFC	Interline Power Flow Controller
MMF	Magneto motive force
PSS	Power System Stabilizer
SMIB	Single Machine Infinite Bus
SSR	Subsynchronous Resonance
SSSC	Static Synchronous Series Compensator
STATCOM	Static Synchronous Compensator
SVC	Static VAR Compensator
TCR	Thyristor Controlled Reactor
TCSC	Thyristor Controlled Series Capacitor
TSC	Thyristor Switched Capacitor
TSSC	Thyristor Switched Series Capacitor
UPFC	Unified Power Flow Compensator

LIST OF FIGURES