

# TABLE OF CONTENTS

	<b>PAGE NO.</b>
<b>CERTIFICATE</b> .....	i
<b>ACKNOWLEDGEMENT</b> .....	ii
<b>ABSTRACT</b> .....	iii
<b>LIST OF ABBREVIATIONS</b> .....	iv
<b>LIST OF FIGURES</b> .....	v
<b>CHAPTER-1 INTRODUCTION AND LITERATURE REVIEW</b> .....	<b>1</b>
<b>CHAPTER-2 SSR AND COMMONLY USED COUNTERMEASURES</b> .....	<b>3</b>
2.1 Role of transmission lines.....	3
2.2 System compensation using series capacitors.....	5
2.3 Mechanical components in the power system.....	5
2.4 Possibilities of shaft damage.....	6
2.5 Subsynchronous resonance (SSR).....	6
2.6 Types of SSR.....	8
2.6.1 Induction Generator effect.....	9
2.6.2 Torsional interaction.....	9
2.6.3 Shaft torque amplification.....	9
2.7 How torsional fatigue can lead to shaft damage.....	10
2.8 Traditional Methods to overcome SSR.....	10
2.8.1 NGH scheme.....	11
2.8.2 Power system stabilizers.....	12
<b>CHAPTER-3 FACTS CONTROLLERS</b> .....	<b>14</b>

3.1	Classification of FACTS controllers.....	14
3.1.1	Series Controllers.....	14
3.1.2	Shunt Controllers.....	15
3.1.3	Combined Series-Series Controllers.....	15
3.1.4	Combined Series-Shunt Controllers.....	15
3.2	Thyristor Switched Capacitor (TSC).....	15
3.3	Thyristor Controlled Reactor (TCR).....	16
3.4	Static VAR Compensator (SVC).....	17
3.5	Static Synchronous Compensator (STATCOM).....	17
3.6	Static Synchronous Series Compensator (STATCOM).....	18
3.7	Thyristor Switched Series Capacitor (TSSC).....	19
3.8	Thyristor-Controlled Series Capacitor (TCSC).....	19
CHAPTER-4	<b>THYRISTOR CONTROLLED SERIES CAPACITOR.....</b>	<b>21</b>
4.1	Introduction.....	21
4.2	TCSC Modes of operation.....	22
4.2.1	Bypassed Thyristor mode.....	22
4.2.2	Blocked Thyristor mode.....	22
4.2.2	Partially conducting mode or Vernier mode.....	23
4.3	Analysis of TCSC.....	24
4.4	TCSC Control Schemes.....	27
4.4.1	Variable reactance model.....	28
4.4.2	Firing angle control model.....	28
4.5	Advantages of TCSC.....	29
CHAPTER-5	<b>SYSTEM MODELING FOR SSR STUDY.....</b>	<b>31</b>
5.1	Mechanical System.....	31

5.1.1 Machine modeling.....	31
5.1.2 Lumped mass model of system.....	37
5.2 Network modeling.....	42
5.2.1 Transmission line.....	42
5.2.2 Shunt capacitance.....	45
5.3 Composite model.....	46
<b>CHAPTER-6 CASE STUDIES AND RESULTS.....</b>	<b>48</b>
6.1 Simulation of SSR.....	48
6.2 System with PSS.....	49
6.3 System with TCSC.....	51
6.4 System with PSS and TCSC.....	58
<b>CHAPTER-7 CONCLUSIONS AND SCOPE FOR FURTHER WORK.....</b>	<b>59</b>
<b>REFERENCES.....</b>	<b>60</b>
<b>APPENDIX A.....</b>	<b>65</b>
<b>APPENDIX B.....</b>	<b>67</b>