POWER SYSTEM STABILITY BY USING TCSC

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ABSTRACT

The loss of transient stability in a power system is due to overloading of some of the lines (or due to severe line faults), as a consequence of tripping off of the other lines after faults or heavy loss of loads. By means of rapid and flexible control over the ac transmission parameters and network topology, FACTS technology can facilitate power control, enhance the power transfer capacity, decrease the line losses, increase power system damping and improve the stability and security of the power system. The main aim is to model multi machine system with TCSC (Thyristor Controlled Series Capacitor) controllers in MiPower software.

Keywords -Transient Stability, Tripping Off, FACTS , TCSC, Mi Power Software

I. INTRODUCTION

The main aim of the paper is to maintain system stability using Thyristor Controlled Series Capacitor. The reason of using TCSC Thyristor Controlled Series capacitor (TCSC) is a power electronics based Flexible AC Transmission System (FACTS) device. TCSCs are used to enhance the power flowing in a line by effectively compensating the reactance of the line. The difference between a conventional series capacitor and a TCSC is that a TCSC can dynamically vary its compensation whereas a conventional series capacitor has a fixed compensation. The basic conceptual TCSC module comprises a conventional fixed series capacitor, C1, a fixed capacitor in parallel, C2, with a thyristor-controlled reactor, L, as shown in Fig 1.1. However, a practical TCSC module also includes protective equipment.

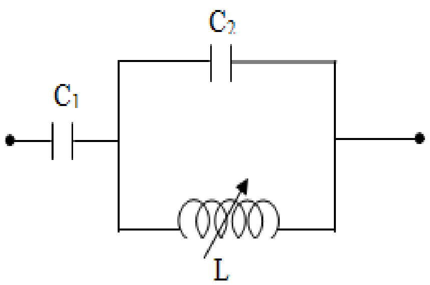


Fig. 1.1 Equivalent Circuit

II. 5-BUS SYSTEM STABILITY

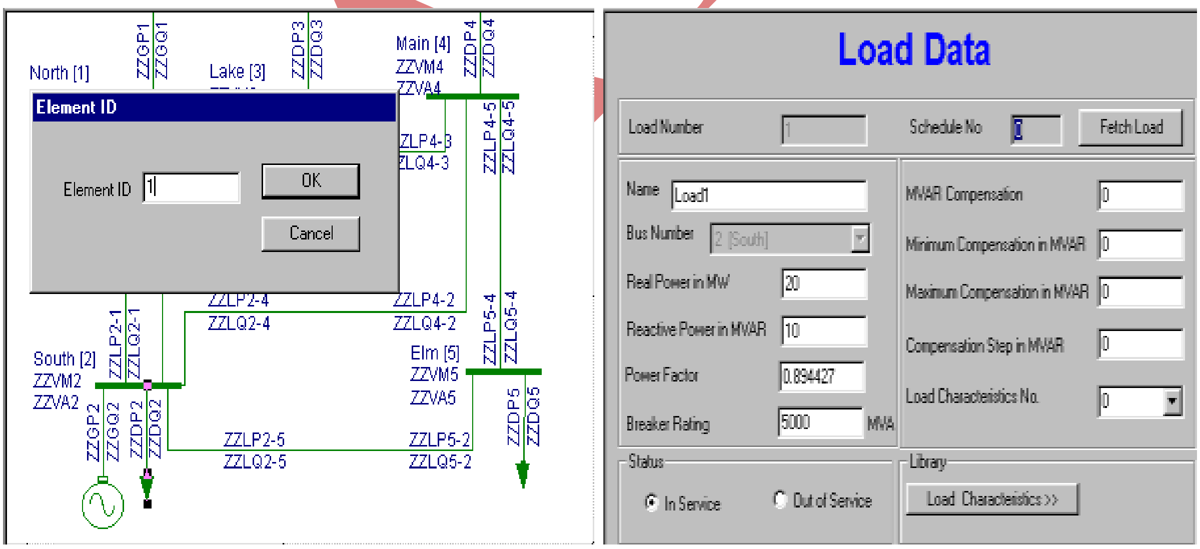
The single line diagram of a 5 bus system is represented with two generating units and seven lines. Per-unit transmission line series impedances and shunt susceptances are given on 100 MVA base. Real power generation, real and reactive power loads in MW and MVAR are given in table.

Improve the power flow through the line 3-4 to 21 MW with TCSC. Assume the base voltage for the bus as 220 kV and system frequency as 60 Hz.

Transmission Line Data in per unit		
Bus code From – To	**Impedance R+jX**	**Line charging B/2**
1-2	0.02+j0.06	0.08+j0.24
1-3	0.08+j0.24	0.0+j0.025
2-3	0.06+j0.18	0.0+j0.02
2-4	0.06+j0.18	0.0+j0.02
2-5	0.04+j0.12	0.0+j0.015
3-4	0.01+j0.03	0.0+j0.010
4-5	0.08+j0.24	0.0+j0.025

Load & Generation Data					
Bus No.	Bus voltage in pu	Generation MW	Generation MVAR	Load MW	Load MVAR
1	1.06+j0.0	0	0	0	0
2	1.00+j0.0	40	30	20	10
3	1.00+j0.0	0	0	45	15
4	1.00+j0.0	0	0	40	5
5	1.00+j0.0	0	0	60	10

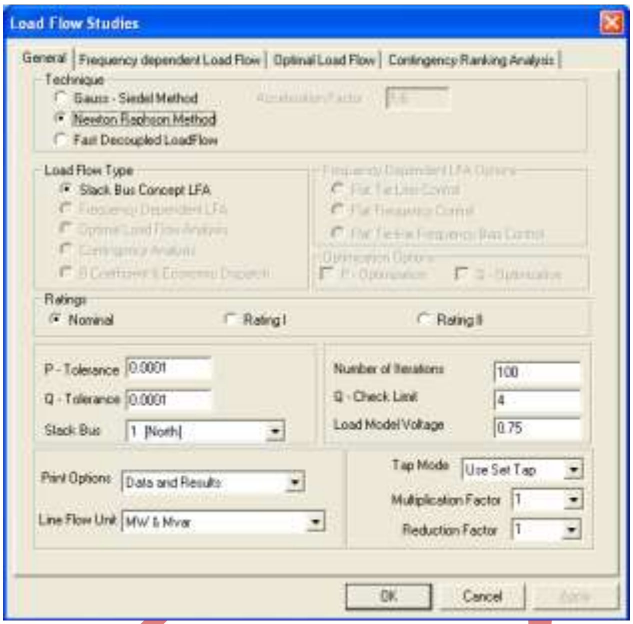
III. LOAD FLOW ANALYSIS



Connect other loads to buses 3, 4 and 5. Enter other load details as given in the following table.

Load Details

Load No	Bus No	MW	MVAR
2	5	60	10
3	3	45	15
4	4	40	5



Execute load flow analysis and click on Report in load flow analysis dialog to view report. Part of the report is shown below.

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BUS VOLTAGES AND POWERS

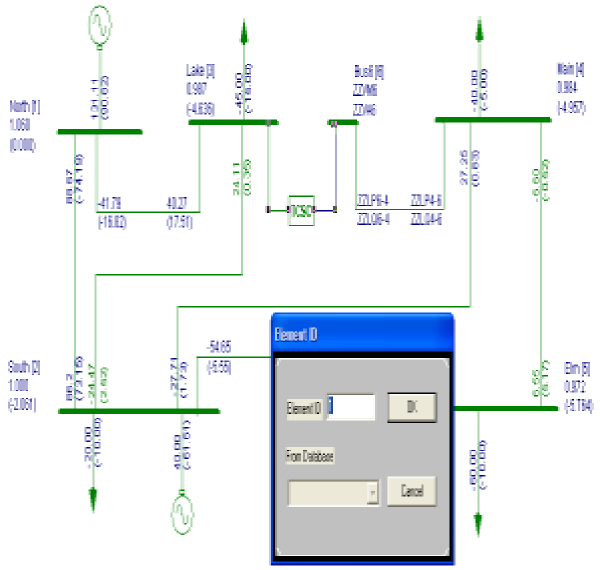
NODE FROM      V-MAG  ANGLE      MW      MVAR       MW     MVAR     MVAR
NO.  NAME       P.U.  DEGREE    GEN      GEN       LOAD    LOAD     COMP
---- --------  ------ ------  -------- --------  -------- -------- --------
  1   North    1.0600   0.00   131.122   90.816    0.000    0.000    0.000 #>
  2   South    1.0000  -2.06    40.000  -61.593   20.000   10.000    0.000
  3    Lake    0.9872  -4.64     0.000    0.000   45.000   15.000    0.000
  4    Main    0.9841  -4.96     0.000    0.000   40.000    5.000    0.000
  5     Elm    0.9717  -5.76     0.000    0.000   60.000   10.000    0.000
---------------------------------------------------------------------------------
NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) :   0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) :   1
NUMBER OF GENERATORS EXCEEDING MINIMUM Q LIMIT (< mark)  :   0
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark)  :   1

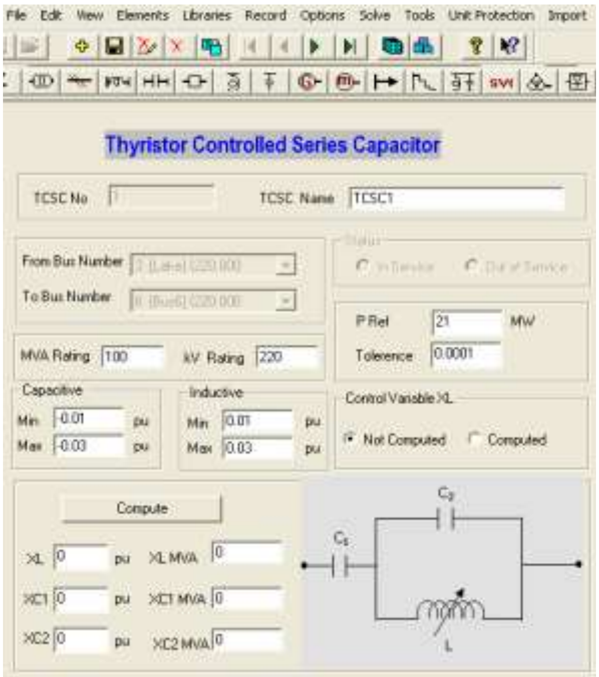
---------------------------------------------------------------------------------
LINE FLOWS AND LINE LOSSES

SLNO CS FROM FROM     TO TO            FORWARD            LOSS           %
        NODE NAME    NODE NAME       MW     MVAR       MW     MVAR   LOADING
---- -- ---- -------- ---- -------- -------- -------- -------- -------- -------
  1  1   1    North    2    South   89.331   73.995   2.4859   1.0868  109.4
  2  1   1    North    3     Lake   41.791   16.820   1.5178  -0.6922   42.5
  3  1   2    South    3     Lake   24.473   -2.518   0.3595  -2.8708   24.6
  4  1   3     Lake    4     Main   19.386    2.865   0.0401  -1.8230   20.2
  5  1   4     Main    5      Elm    6.598    0.518   0.0431  -4.6525    8.6
  6  1   2    South    5      Elm   54.660    5.558   1.2150   0.7287   54.9
  7  1   2    South    4     Main   27.713   -1.724   0.4609  -2.5545   27.8
```

IV. APPLICATION OF TCSC

The purpose of connecting TCSC is to improve the power flow in the line3-4 from 19.38MW to 21 MW. Before connecting the TCSC, line 3-4 is disconnected/made out of service/deleted and another bus (Bus6) is added between Bus3 and Bus4. Connect a transmission line with parameters same as line 3-4 between Bus6 and Bus4. Click on TCSC icon provided in the power system tool bar and connect it between Bus3 and Bus6, in the similar way as the other series elements are connected. Give ID No as 1 and say OK. TCSC form will appear.





BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG P.U.	ANGLE DEGREE	MW GEN	MVAR GEN	MW LOAD	MVAR LOAD	MVAR COMP
1	North	1.0600	0.00	131.127	90.937	0.000	0.000	0.000 #>
2	South	1.0000	-2.04	40.000	-61.802	20.000	10.000	0.000
3	Lake	0.9870	-4.73	0.000	0.000	45.000	15.000	0.000
4	Main	0.9844	-4.81	0.000	0.000	40.000	5.000	0.000
5	Elm	0.9718	-5.70	0.000	0.000	60.000	10.000	0.000
6	Bus6	0.9876	-4.46	0.000	0.000	0.000	0.000	0.000

NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) : 0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) : 1
NUMBER OF GENERATORS EXCEEDING MINIMUM Q LIMIT (< mark) : 0
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark) : 1

LINE FLOWS AND LINE LOSSES

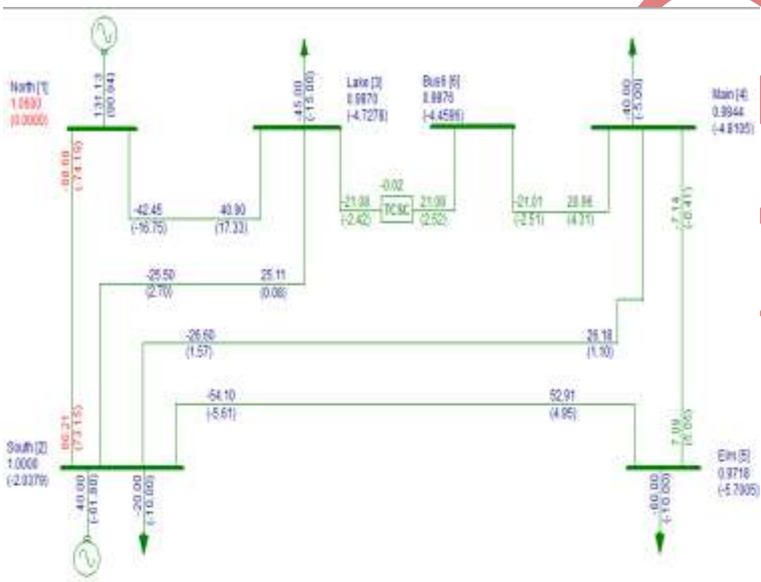
SLNO	CS	FROM NODE	FROM NAME	TO NODE	TO NAME	FORWARD MW	FORWARD MVAR	LOSS MW	LOSS MVAR	% LOADING
1	1	1	North	2	South	88.676	74.188	2.4704	1.0405	109.1@
2	1	1	North	3	Lake	42.451	16.749	1.5554	-0.5783	43.1^
3	1	2	South	3	Lake	25.503	-2.695	0.3905	-2.7769	25.6^
4	1	4	Main	5	Elm	7.137	0.413	0.0487	-4.6377	9.0&
5	1	2	South	5	Elm	54.103	5.606	1.1911	0.6565	54.4$
6	1	2	South	4	Main	26.600	-1.566	0.4246	-2.6642	26.6^
7	1	6	Bus6	4	Main	21.008	2.509	0.0465	-1.8049	21.7&

TCSC POWER FLOWS

SLNO	FROM NODE	TO NODE	FORWARD (MW)	(MVAR)	LOSS (MVAR)	TCSC REACT.	Final XL_Value
1	3	6	21.08	2.42	-0.10	-0.0216	-

After connecting the TCSC the power flow through the line is improved to 21 MW and the reactance of TCSC is capacitive and its magnitude is 0.0216 per unit.

TCSC output on the GUI Screen is given below



V. CONCLUSION

The power system stability using TCSC is discussed and the dynamics of the system is compared during a major disturbance.TCSC is used to enhance the power flowing in a line by effectively compensating the reactance of the line. Initially the system is unstable and after the addition of TCSC the power flow is improved in the line3-4 from 19.38MW to 21 MW. From the data and the results a considerable improvement is seen in the overall performance of the system.

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