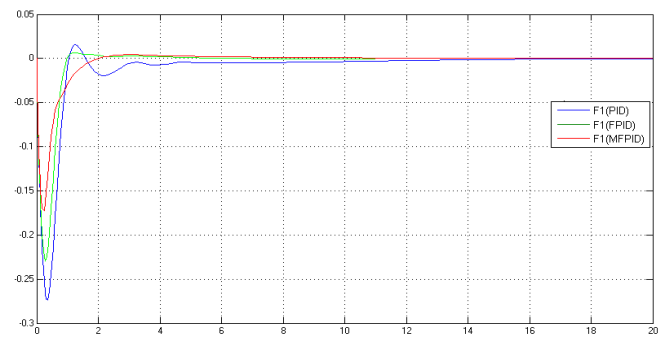
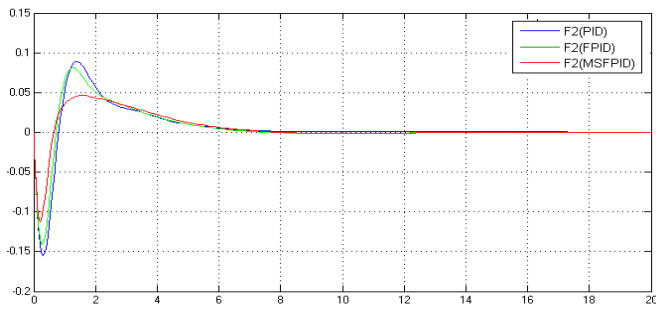


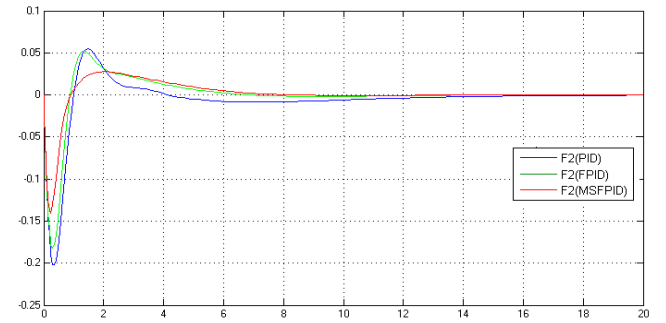
**Figure 11:** Frequency deviation in Area1 ( $\Delta F1$ ) with PID, FPID and MSFPID controllers



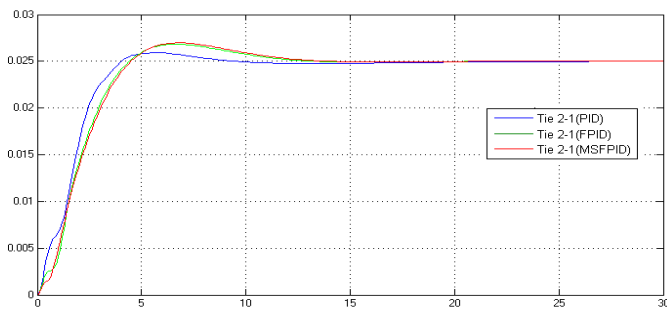
**Figure 15:** Frequency deviation in Area1 ( $\Delta F1$ ) with PID, FPID and MSFPID controllers



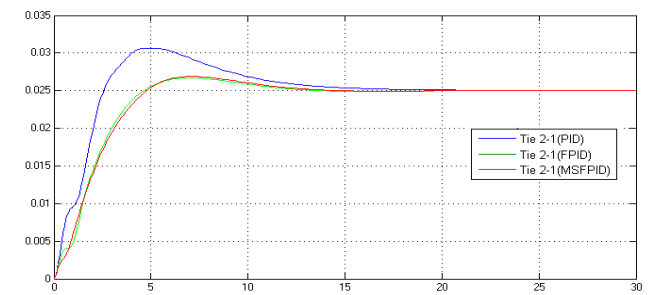
**Figure 12:** Frequency deviation in Area2 ( $\Delta F2$ ) with PID, FPID and MSFPID controllers



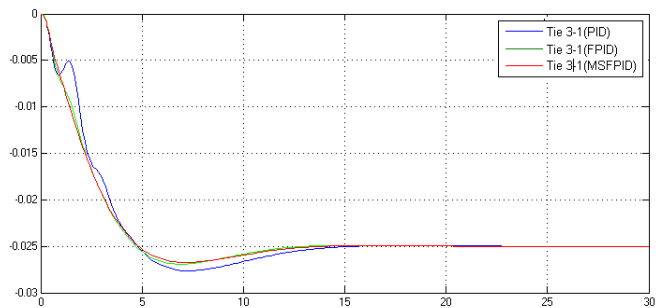
**Figure 16:** Frequency deviation in Area2 ( $\Delta F2$ ) with PID, FPID and MSFPID controllers



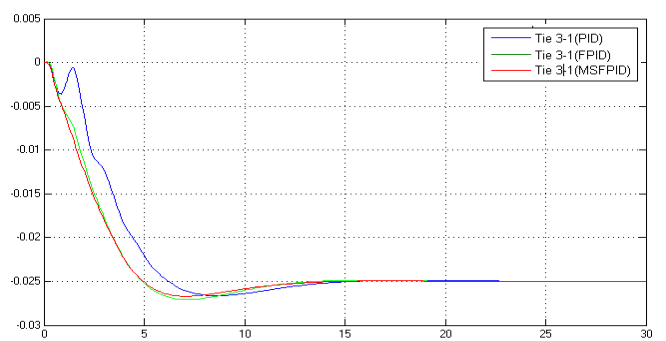
**Figure 13:** Tie line power flow variation ( $\Delta P$  tie 2-1) with PID, FPID and MSFPID controllers



**Figure 17:** Tie line power flow variation ( $\Delta P$  tie 2-1) with PID, FPID and MFPID controllers



**Figure 14:** Tie line power flow variation ( $\Delta P$  tie 3-1) with PID, FPID and MSFPID controllers



**Figure 18:** Tie line power flow variation ( $\Delta P$  tie 3-1) with PID, FPID and MSFPID controllers

**Scenario-3: Contract Violation**

It is assumed that a large step load of 0.1pu is demanded by each DISCO in three areas and in addition to the specified contracted load demands, DISCO 1 in area 1, DISCO 1 in area 2 and DISCO 2 in area 3 demands 0.05, 0.04 and 0.03pu as large un-contracted loads, respectively.

**Table VI:** Performance indices of IAE, ITAE, and ITSE under different scenarios

	Poolco		
	IAE	ITAE	ITSE
PID	47.49	18.55	4.65
FPID	23.84	12.37	1.54
MSFPID	<b>22.93</b>	<b>9.98</b>	<b>1.11</b>
	Bilateral		
	IAE	ITAE	ITSE
PID	59.62	26.28	6.29
FPID	38.12	18.36	2.89
MSFPID	<b>34.28</b>	<b>14.7</b>	<b>2.02</b>
	Violation		
	IAE	ITAE	ITSE
PID	95.90	36.56	11.79
FPID	28.12	19.06	3.88
MSFPID	<b>28.06</b>	<b>15.33</b>	<b>1.18</b>

## 7. Conclusion

The modeled system is tested under three different scenarios namely, poolco based transactions, combination of poolco and bilateral transactions and contract violation transactions. The frequency deviation and tie line power variations in three areas under different scenarios are less with MSFPID controller when compared to FPID and PID controllers. The system performance characteristics in terms 'IAE', 'ITAE', 'ITSE' reveals that the performance of MSFPID is comparatively better than other controllers.

## Appendix

**Table VII:** GENCO Parameters

	1-1	2-1	1-2	2-2	1-3	2-3
Rated(MW)	1000	800	1100	900	1000	1020
$T_T$ (s)	0.32	0.30	0.30	0.32	0.31	0.34
$T_G$ (s)	0.06	0.08	0.06	0.07	0.08	0.06
R(Hz/pu)	2.4	2.5	2.5	2.7	2.8	2.4
A(apf)	0.5	0.5	0.5	0.5	0.6	0.4

**Table VIII:** Control area parameters

Parameter	Area-1	Area-2	Area-3
$K_p$ (Hz/pu)	120	125	120
$T_p$ (s)	20	25	20
B(pu/Hz)	0.4250	0.3966	0.3522
$T_{ij}$ (pu/Hz)	$T_{12}=0.245, T_{13}=0.212$		

**Table IX:** PID controller gains:

Area	$K_d$	$K_p$	$K_i$
1	0.2	0	0.3
2	0.3	0.1	0.9
3	0.1	0.3	0.6

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## Author Profile



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