Under Frequency Load Shedding For Distribution System

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***Abstract*— Safe operation of a power system will require that system frequency is kept within a specified range. When the generation is in sufficient due to disturbances, the frequency might fall under the minimum allowable value which may lead to system blackout if not property counteracted. This frequency decline may be corrected by shedding certain amount load so that the system is back into balanced state. Under Frequency Load Shedding, UFLS, is the last step and the most extreme in protecting electric power systems from black outs and severe damages. UFLS scheme is investigated simulating different disturbance in IEEE 3-generator 9-bus test system.**

***Keywords*—Under Frequency Load Shedding(UFLS),Load Shedding, Reliability, Adaptive control, Dynamic simulation, Frequency stability, power system protection.**

I. INTRODUCTION

Power system stability is defined as that property of a power system that enables it to exist in a state of operating equilibrium under normal operating under normal condition and to region an acceptable state of equilibrium after being subjected to a disturbance (Kundar, Balu, Lauby 1994) The protection systems should be designed so that to take preventative action when system contingency (such as faults, major generator or line outages) occur. However, preventive action disrupts the power in the affected area and by doing so the rest of the power system remain in a stable condition.

Generally, power systems experience either frequency or voltage instability problem. If there action taken to recover the system to its normal state ,pre-disturbance, the consequence can be catastrophic. In addition to that ,a power system may experience a rotor angle instability of interconnected synchronous machines of a power system to remain in synchronism in this study, only frequency instability is considered. For satisfactory operation of a power system, the frequency should remain nearly constant. Some of the disturbances experienced by the power system are faults, loss of a generator, sudden switching of loads[1],[3].These disturbances vary in their intensity. At times these disturbances might cause the system to be unstable. For example, when a sudden large industrial load is switched on, the system may become unstable. As a result it is necessary to study the system and monitor it in order to prevent it from becoming unstable. The two most important parameters to monitor are the system voltage and frequency. The voltage at all the buses and the frequency, both of which must be maintained within prescribed limits to ensure that the system remains stable. The frequency is mainly affected by the active power, while the voltage is mainly affected by the reactive power.

Specifically, the frequency is affected by the difference between the generated power and the load demand. This difference is caused due to disturbances which reduce the generation capacity of the system. For example, due to the loss of a generator, the generation capacity decreases while the load demand remains constant. If the other generators in the system are unable to supply the power needed, then the system frequency begins to decline. To restore the frequency within the prescribed limits a load shedding scheme is applied to the system. Voltage is a measure of the balance of MVAr load and MVAr capability within a power system and the frequency stability is normally associated with the balance between the real power generated and the real power required by the load. As frequency is a common factor throughout the system, a change in active power demand at one point is reflected throughout the system by change in frequency.

II. LOAD SHEDDING

In general, load shedding can be defined as the amount of load that must almost instantly be removed from a power system to keep the remaining portion of the system operational. This load reduction is in response to a system disturbance (and consequent possible additional disturbances) that results in a generation deficiency condition. Common disturbances that can cause this condition to occur include faults, loss of generation, switching errors, lightning strikes, etc.

Generally, when there is a system disturbance in the power system, When a power system is exposed to a disturbance, its dynamics and transient responses are mainly controlled through two major dynamic loops. One is the excitation (including AVR) loop that will control the generator reactive power and system voltage. Another is the prime-mover loop, which will control the generator active power and system frequency.

III. UNDER FREQUENCY LOAS SHEDDING (UFLS)

UFLS is a protection scheme which continuously monitors power system frequency. It initiates a trip signal to shed load, if required, to bring system frequency back to acceptable stable conditions. In conventional UFLS the amount of disturbance power is determined by performing stability studies. A common practice is to shed half of the load block when the frequency is lower than the threshold value. The amount of power shed is irrespective of to the disturbance location i.e. conventional UFLS does not take into consideration how far the disturbance location is from load buses, which is the main disadvantage of conventional UFLS. Practically, the load shedding is normally executed in multiple stages, with different sets for frequencies and time delays.

Generally, when there is a system disturbance in the power system, the voltages at buses in the affected area experience voltage sag depending on the severity, location and type of the disturbance. Therefore, the bus voltage could be used as a valuable indicator for system disturbance, and also to determine how far the disturbance is from the load buses. If the demand is significantly higher than the generation, the system will ability experience under frequency conditions, and under frequency load shedding (UFLS) relays should operate in order to bring the system frequency back to stable conditions by shedding the load. On the other hand, if the generation is significantly higher than the load, the frequency of the system will increase, and over frequency relays should operate to bring the frequency back to its normal value by tripping generator(s).

The power system frequency as well as voltage has a certain operating limits. The protection system should not operate when the system conditions lie within these allowable limits. Whenever these limits are not met, the associated protection system should operate. Under/over-frequency relays should operate whenever the system frequency is lower/higher than the minimum/maximum limits.

IV. IEEE 9 BUS TEST SYSTEM :

The 9 bus sample system consists of 9 buses and 3 generating units in MATLAB software out of which one is the swing bus. The data given with the sample system is the generator data -including the time constants and the inertia constants, the transmission line data the line impedances and branch connections and the load data. The single line diagram of the system is shown in figure1.

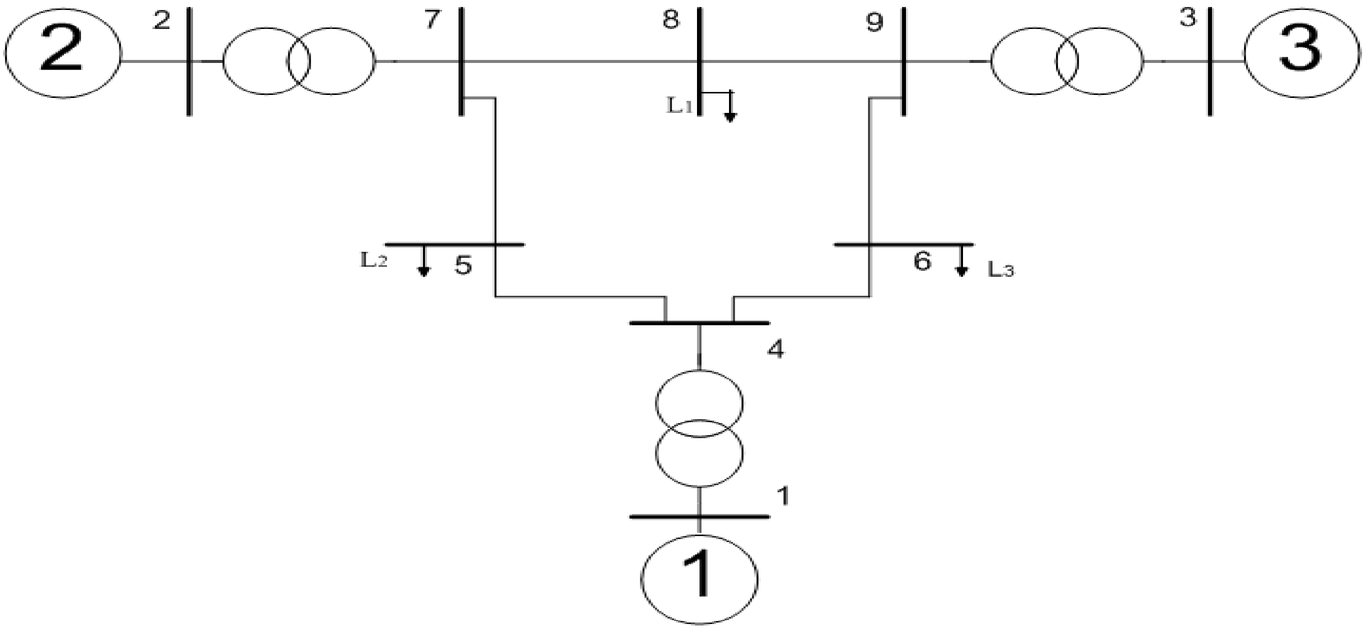


Fig..1 Single Line Diagram of IEEE 9 Bus Syatem

Table-I(Generator Data)-

Generator	Voltage(pu)	Phase Angle (degree)	Frequency(Hz)	Rated MVA
1	16.8	0	60	247.5
2	13	0	60	192
3	18.8	0	60	128

Table-II

(Transformer Data)

x'mer	P Mva	F hz	V1 kv	R1 pu	L1 pu	V2 kv	R2 pu	L2 Pu	Rm pu	Lm pu
1	192	60	18	0.0	0.0625	230	0.0	0.0625	500	500
2	250	60	230	0.0	0.0576	16.5	0.0	0.0576	500	500
3	128	60	230	0.0	0.0586	13.8	0.0	0.0586	500	500

Table-III (Bus Data)

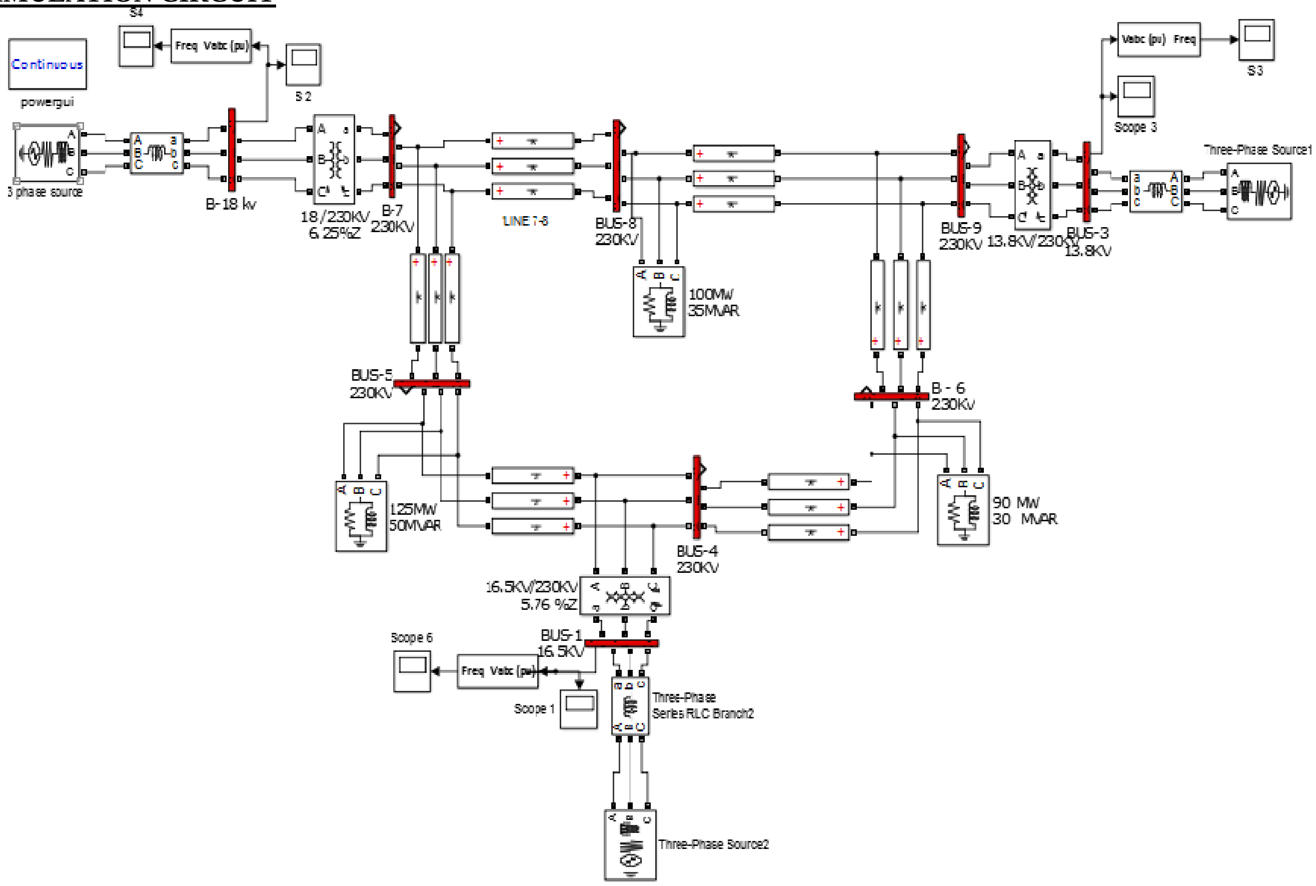
Bus No.		Half line charging Admittance(p.u.)	Reactance (p.u.)	Resistance (p.u.)
From Bus	To Bus			
1	4	0.0	0.0576	0.0
4	6	0.079	0.092	0.017
5	9	0.0	0.0586	0.0
6	9	0.179	0.17	0.039
5	7	0.153	0.161	0.032
7	8	0.0745	0.072	0.0085
2	7	0.0	0.0625	0.0
8	9	0.1045	0.1008	0.0119

V. Load Flow Result

Table-IV (Bus Data)

Bus No.	Voltage magnitude(pu)	Phase Angle (degree)
1	1.00	-0.05
2	1.00	0.18
3	1.00	-0.41
4	0.95	19.78
5	0.103	-12.54
6	0.99	12.42
7	0.96	16.90
8	1.02	-18.73
9	0.95	-11.72

VI SIMULATION CIRCUIT



VII. SIMULATION RESULTS:

(1)When system in Normal Condition:

The frequency Response of generator one ,two and three are:

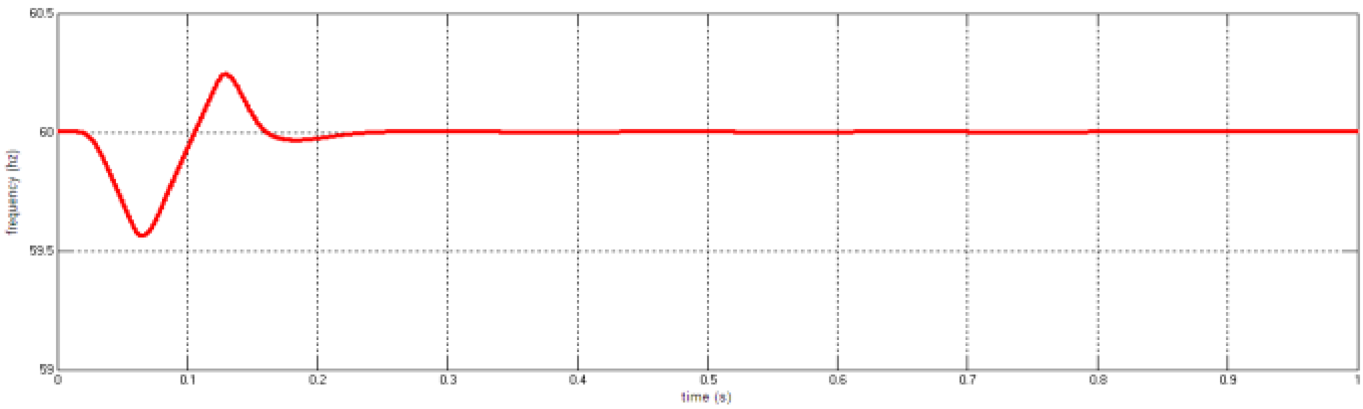


Fig.2 Frequency Response of Generator 1

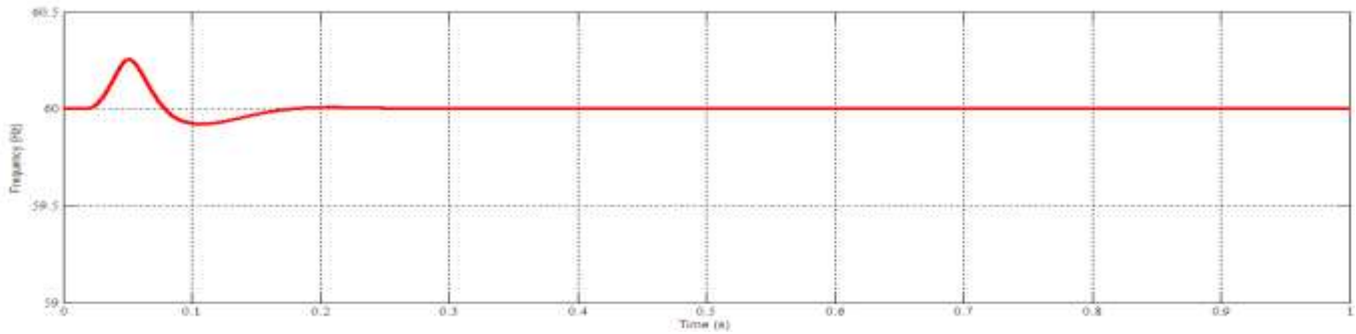


Fig.3 Frequency Response of Generator 2

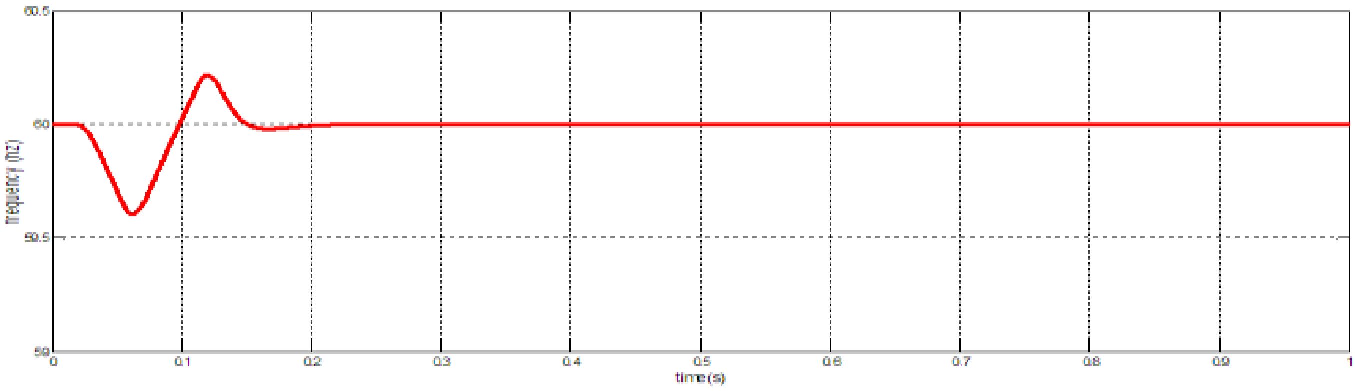


Fig.4 Frequency Response of Generator 3

(2) Three generator outage disturbances are applied to the simulated system as follows:

Case1: Outage of generator G1 with 247.5 Mva generations

Case 2: Outage of generator G2 with 192 Mva generations;

Case 3: Outage of generator G3 with 128 Mva generations;

Case1: Outage of generator G1:

The frequency Response of generator one ,two and three are:

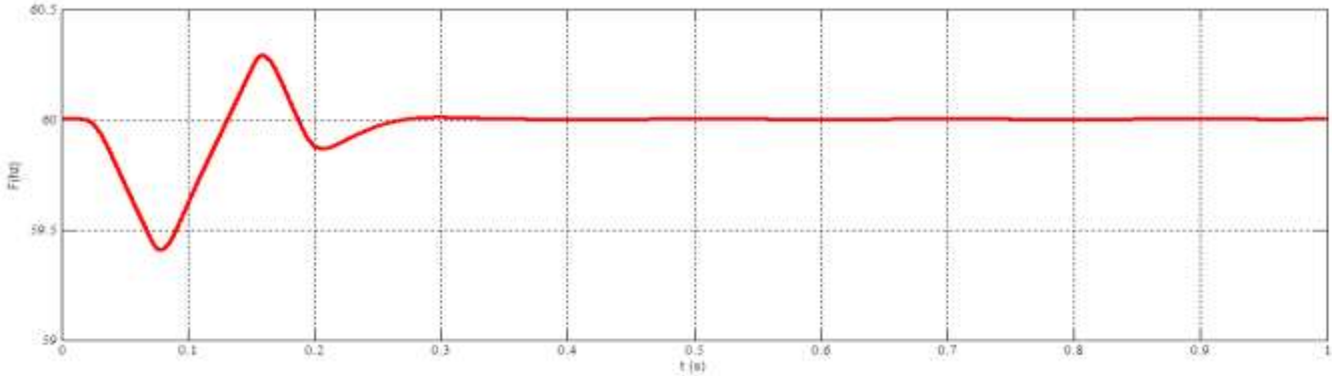


Fig.5 Frequency Response of Generator 1

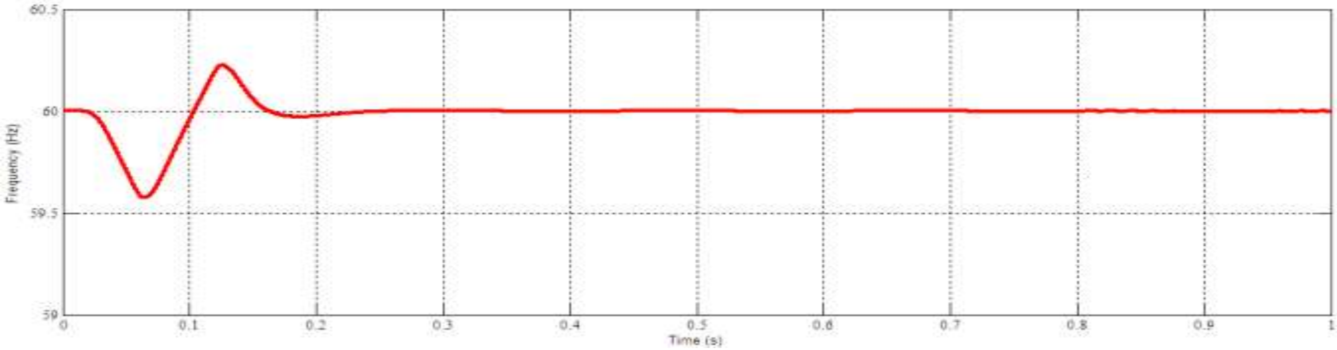


Fig.6 Frequency Response of Generator 2

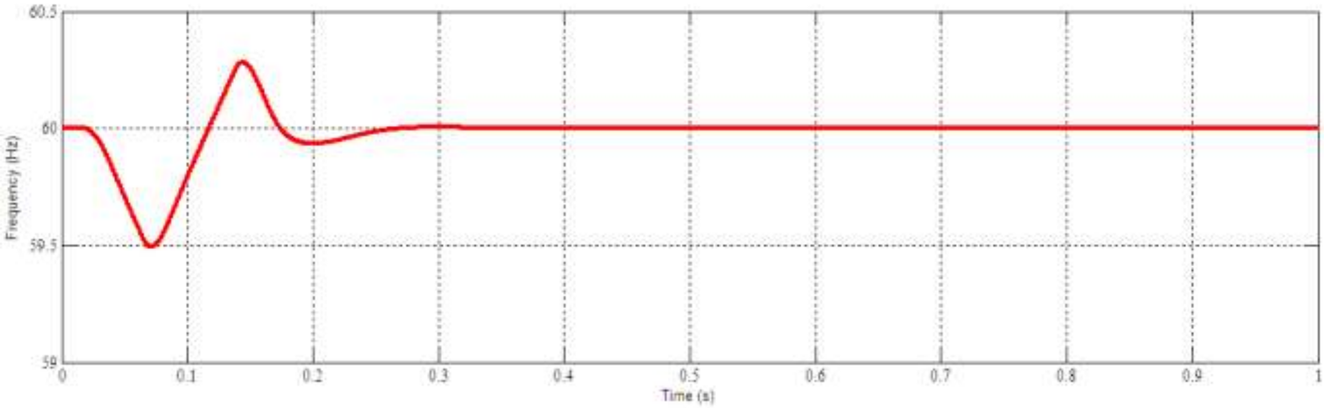


Fig.7 Frequency Response of Generator 1

Case 2: Outage of generator G2:

The frequency Response of generator one ,two and three are:

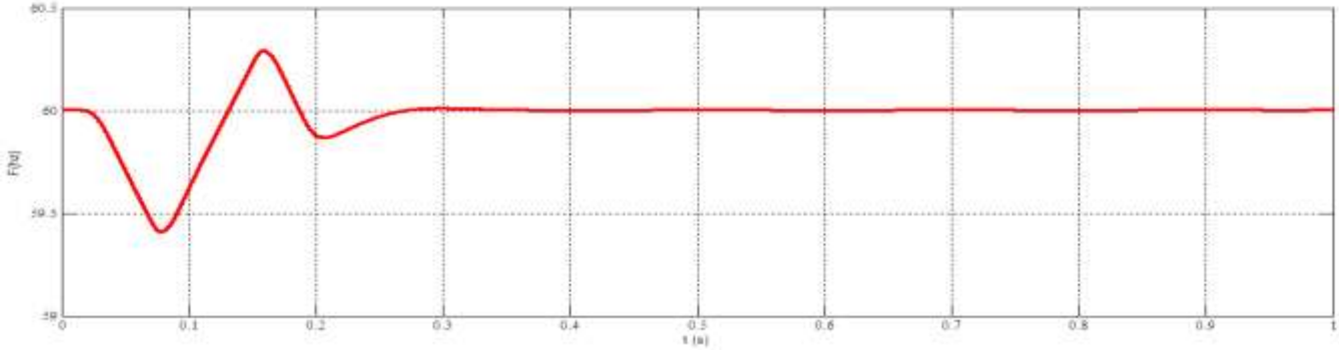


Fig.8 Frequency Response of Generator 1

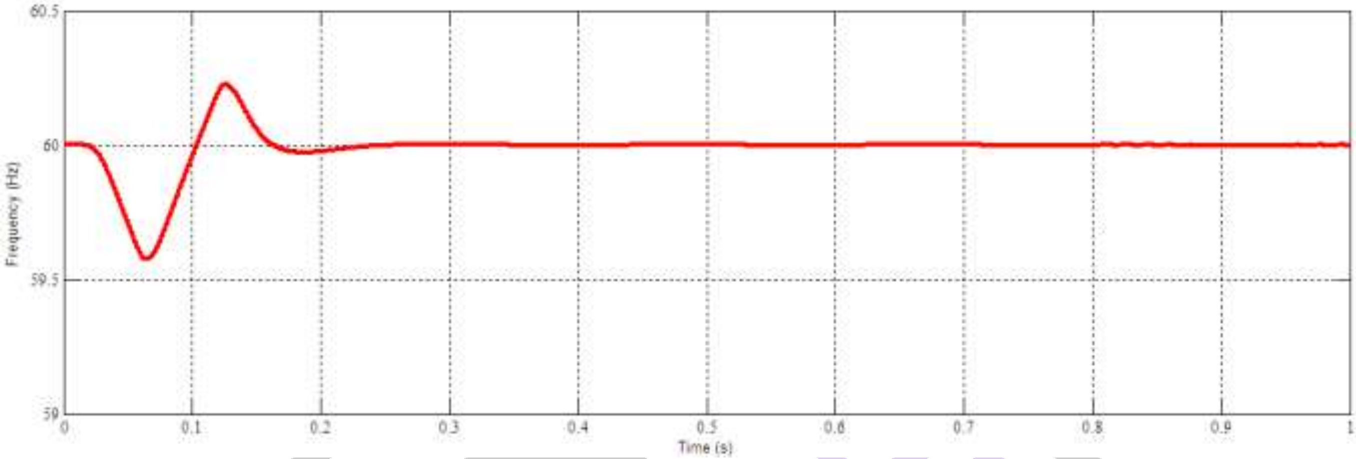


Fig.9 Frequency Response of Generator 2

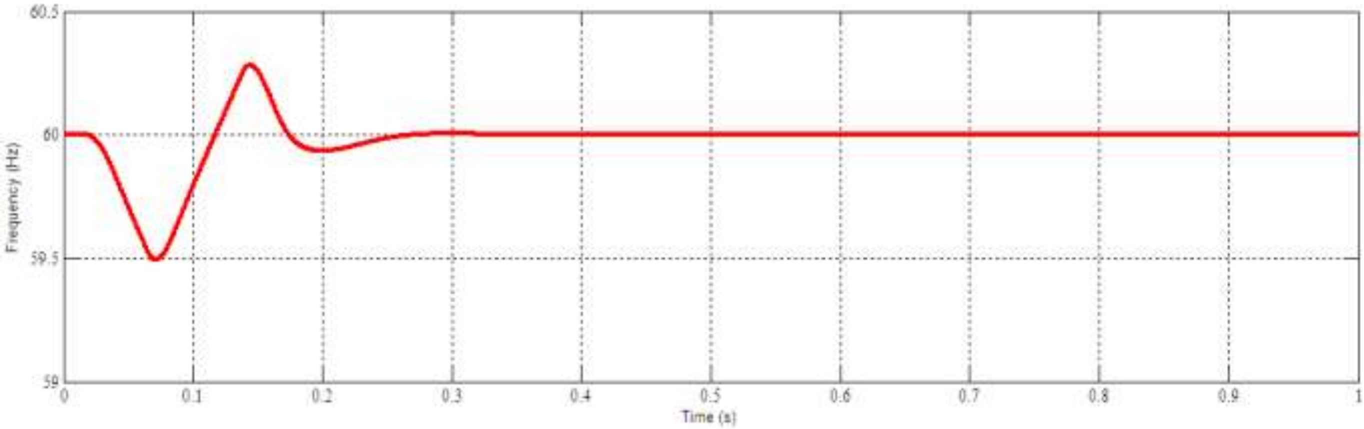


Fig.10 Frequency Response of Generator 3

Case3: Outage of generator G3:

The frequency Response of generator one ,two and three are:

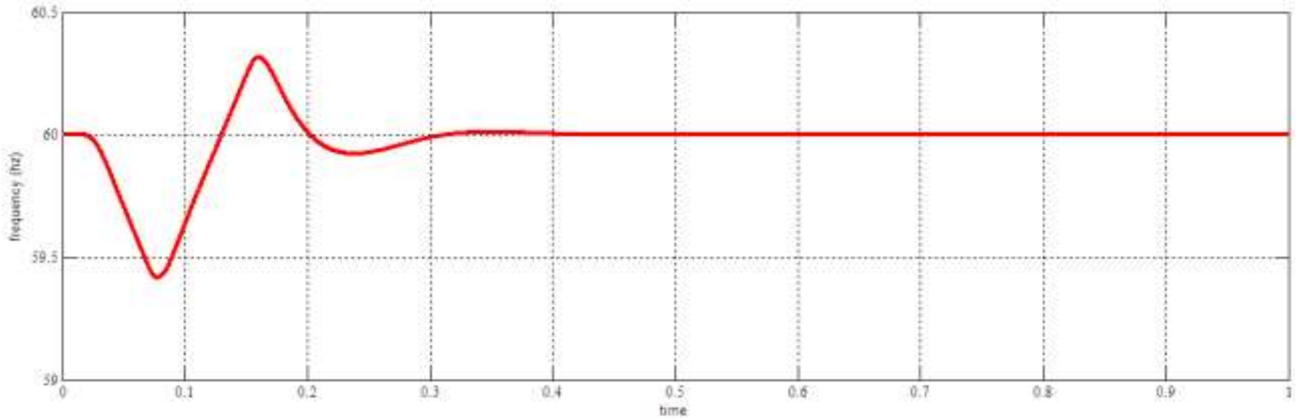


Fig.11 Frequency Response of Generator 1

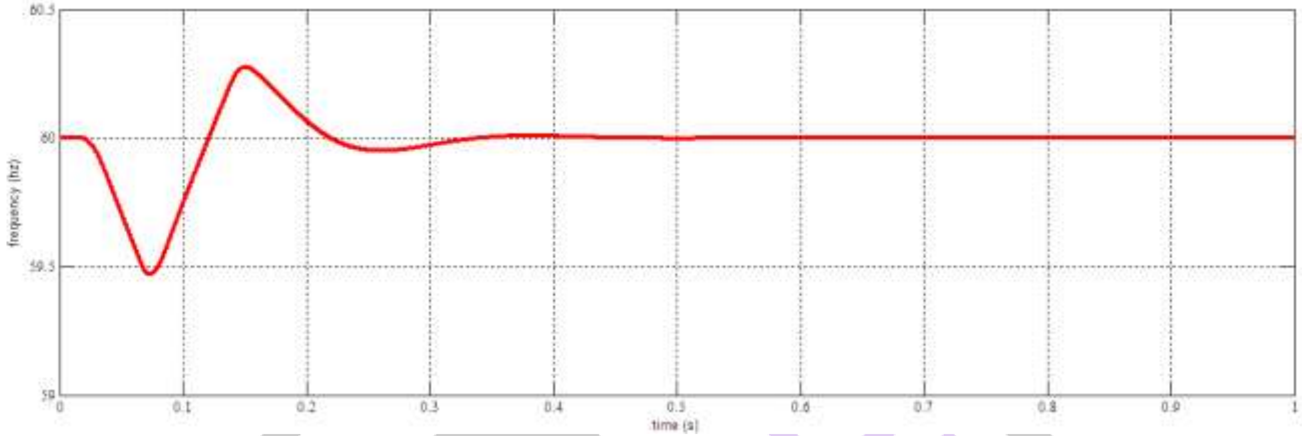


Fig.12 Frequency Response of Generator 2

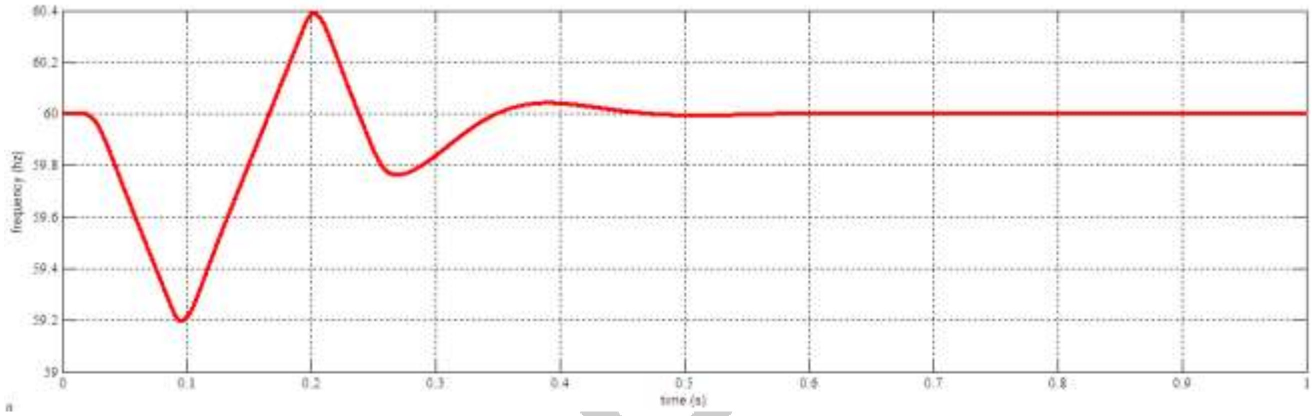


Fig.13 Frequency Response of Generator 3

CONCLUSION

After reviewing few papers, it is clear that load shedding is necessary for the power system under certain circumstances like faults loss of generation system islanding, switching errors, lightning strikes.

Literature review of few techniques has been carried out and it is concluded that if a technique is developed by which UFLS can be done earliest possible then possible damage can be prevent.

Change of frequency can be observed when unbalance take place between generation and demand.

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