Title: Power system modeling of a 4-bus system using varying load from OpenIPSL

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Abstract:

The simulation presents power system modelling of a 4-bus system consisting of 1 generator of order ii at bus 4 and an infinite bus at bus 1. Time varying loads are connected at all the buses except at bus 1. Bus 1 is considered as a slack bus. The load variations are different for different buses. The duration for each variation is 5 seconds. Opening and reclosing of line 2_4 between bus 2 and bus 4 starting from 70 sec for duration of 5 seconds is also provided. The power system model is shown in Figure 1.

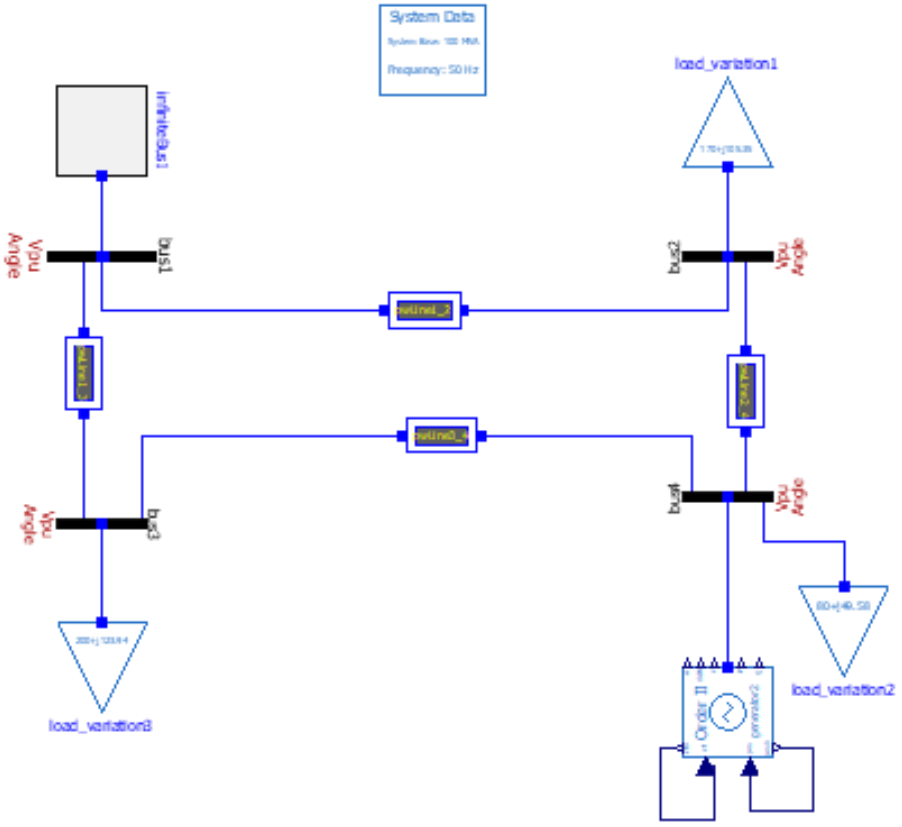

Figure 1: Power System Model

Explanation:

The model uses the following components

Component name	Path	Quantity
Generator (order 2)	OpenIPSL.Electrical.Machines.PSAT.Order2	1
Bus	OpenIPSL.Electrical.Buses.Bus	4
Transmission Line	OpenIPSL.Electrical.Branches.PwLine	4
Load	OpenIPSL.Electrical.Loads.PSSE.Load_variation	3
System block	OpenIPSL.Electrical.SystemBase	1
Infinite bus	OpenIPSL.Electrical.Buses.InfiniteBus	1

The above model is subjected to different conditions at different time periods in order to observe the voltage profiles at the buses. The conditions which it is subjected to are:

1. The load variation of bus 2 starts at 15 seconds.
2. The load variation of bus 3 starts at 30 seconds.
3. The load variation of bus 4 starts at 40 seconds.
4. Opening and reclosing of line 2_4 between bus 2 and bus 4 starting from 70 seconds.

Case 1: Simulating the load variation at bus 2

The voltage at the bus 2 is shown in the fig 2 and from this we can see that the voltage dips at the time mentioned above which indicates that the system decelerates. Thus, the system decelerates and when the load is cut off after 5 secs the voltage angle oscillates about its steady state value and settles after some time. It is seen that the voltage dips at different times corresponding to the different times of load variation at different buses. The dipping occurs at time 15 secs, 30 secs and 40 secs respectively. However, the voltage dipping at 70 sec is not due to time varying load like the other three but due to line disturbances which is discussed in Case 2.

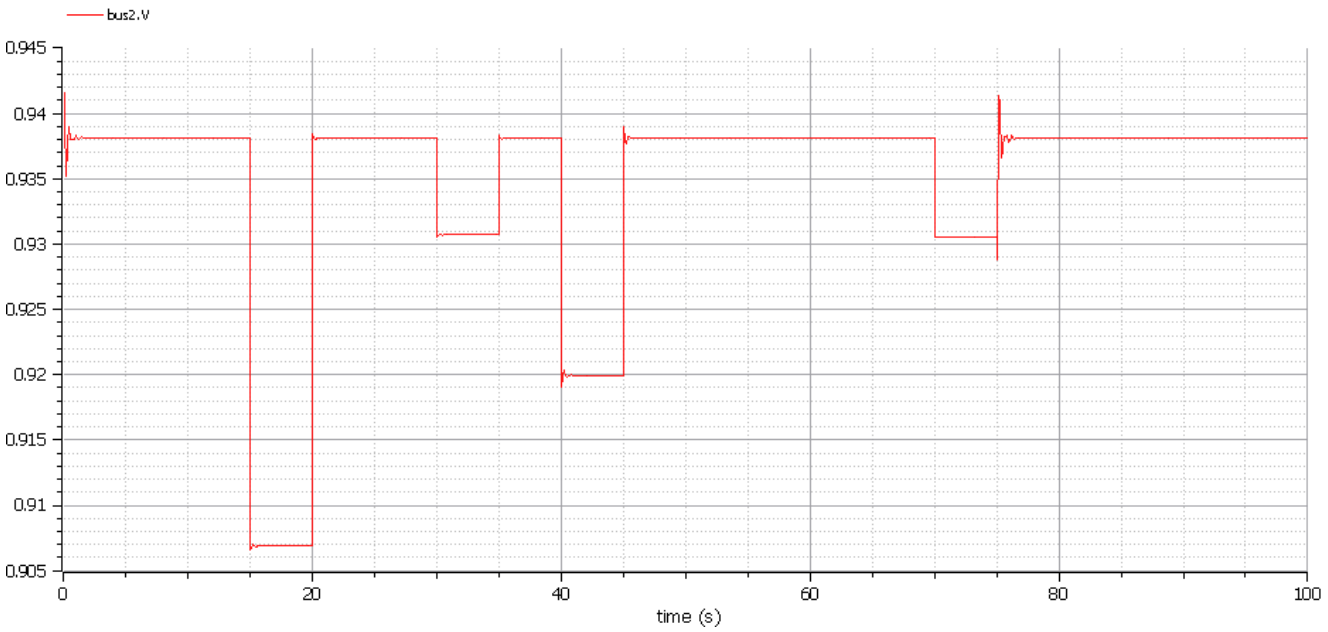

Figure 2: Voltage profile of bus 2

Case 2: Introducing disturbance in line 2_4 starting from 70 sec for 5 secs

In this model, the line between bus 2 and bus 4 (pwline2_4) is opened at 70 secs and reclosed after 5 secs. The voltage profiles for the same is shown in figure 3. We can see that system is stable even after reclosure as there are parallel lines connected at bus 2 and bus 4 individually where the power can be redirected. In this case, even the generator bus voltage starts to oscillate. The effect is same for all the buses except bus 1 which is slack bus. Voltage stability is concerned with the ability of a power system to maintain acceptable voltages at all buses of the system under normal conditions and after the occurrence of a disturbance. A system enters a state of voltage instability when a disturbance, increase in load demand or change in system conditions.

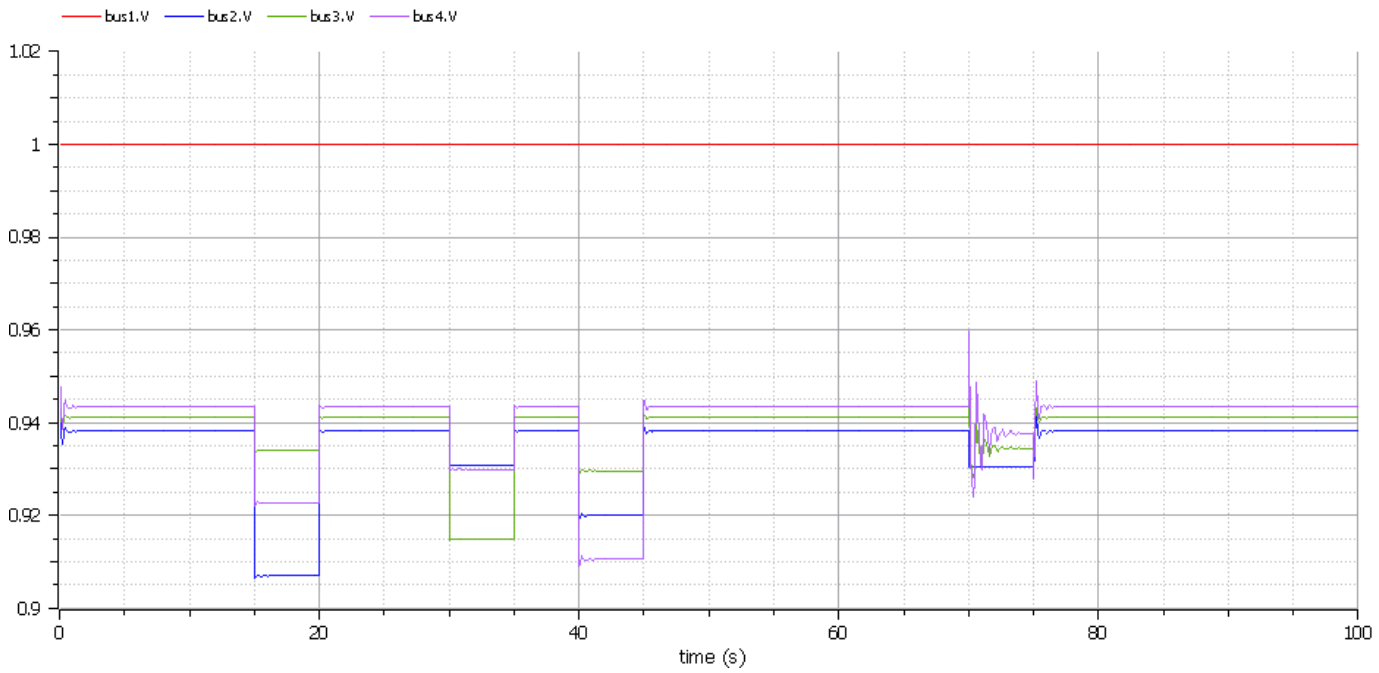

Figure 3:Voltage profile of all the buses

Conclusion:

The model represents the behaviour of the system under time varying load and line disturbances. In the case of reclosure of the power line, the system oscillates and after reclosure it comes back to stable condition. But during the load variation the although the magnitude of oscillation is small but the voltage dipping is considerably large.