Title: Modelling of IEEE modified 30 bus system using Modelica and OpenIPSL

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Abstract:

Modelica implementation of the IEEE modified 30 bus system using the OpenIPSL library is shown in Figure 1. The power system model consists of 4 generators, 2 Synchronous Condensers, 4 transformers, 20 loads, 37 transmission lines. A three winding transformers are replaced by their equivalent connections by a two winding transformers. A single line diagram (SLD) is shown in figure 2. A three-phase balanced fault is simulated at 18$^{th}$ Bus for the duration of 0.4 seconds (4.6 seconds to 5 seconds). The purpose of this power system simulation is to study the voltage stability at multiple buses.

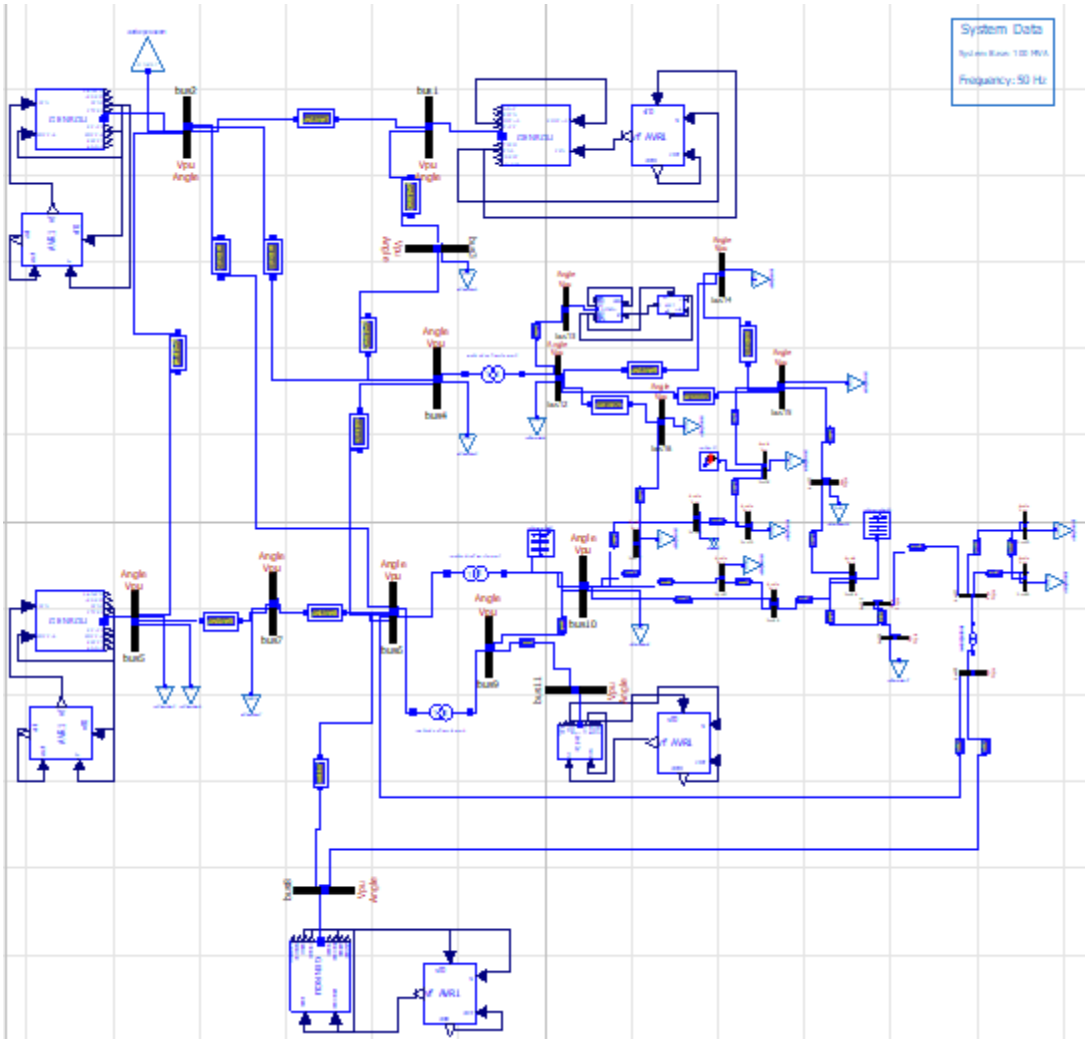


**Figure 1: IEEE modified 30 bus system using Modelica and OpenIPSL**

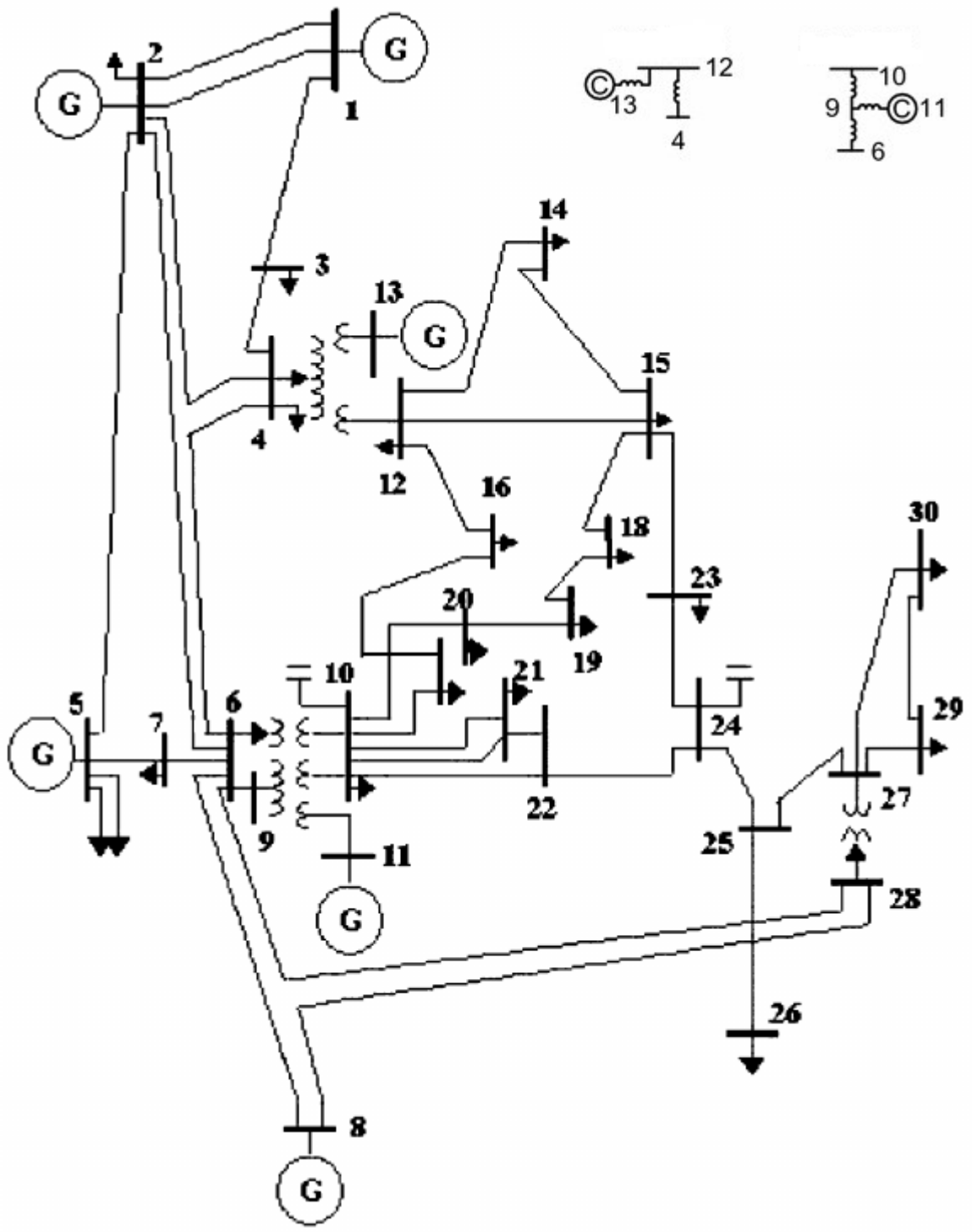


Figure 2: Single line diagram (SLD) of IEEE modified 30 bus system

**Explanation:**

This model uses the following components:

| Component Name | Class Path | Number |
|---|---|---|
| Two Winding Transformer | OpenIPSL.Electrical.Branches.PSAT.TwoWindingTransformer | 4 |
| Three phase fault | OpenIPSL.Electrical.Events.PwFault | 1 |
| Voltage Dependent Load | OpenIPSL.Electrical.Loads.PSAT.VoltDependant | 20 |
| Generators (including synchronous condensers) | OpenIPSL.Electrical.Machines.PSSE.GENROU | 6 |
| Automatic Voltage Regulators (AVR) | OpenIPSL.Electrical.Controls.PSAT.AVR.AVRTypeI | 6 |
| Buses | OpenIPSL.Electrical.Buses.Bus | 30 |
| PwLine | OpenIPSL.Electrical.Branches.PwLine | 37 |
| Sysdata block | OpenIPSL.Electrical.SystemBase | 1 |

**Table 1: Components used in system**

The IEEE modified 30 bus model implemented in Modelica language using OpenIPSL package, is used to study the voltage stability at different buses. The system base is 100 MVA base. For all analysis on this system, the lower voltage magnitude limits at all buses are 0.9 p.u and upper limits are 1.1 p.u. A three winding transformers are replaced by their equivalent connections by a single two winding transformer. The generator models in the implemented network use Automatic Voltage Regulators (AVR) type 1. The purpose of using the AVR is to control the generator field voltage to stabilize this oscillation of the bus voltage after the fault clearing time. Type of generator used is round rotor machine (GENROU). A fault is simulated for the duration of 4.6 to 5 seconds at the $18^{th}$ bus. During the fault, we can observe from the bus voltage profiles, that the voltage dip is more for $18^{th}$ bus as it is the fault bus and the severity of the fault is decreased as we move away from the fault bus. Simulation obtained shows profiles at various buses and wave forms obtained are observed

The simulation result of the all 30 Bus voltages shown below.

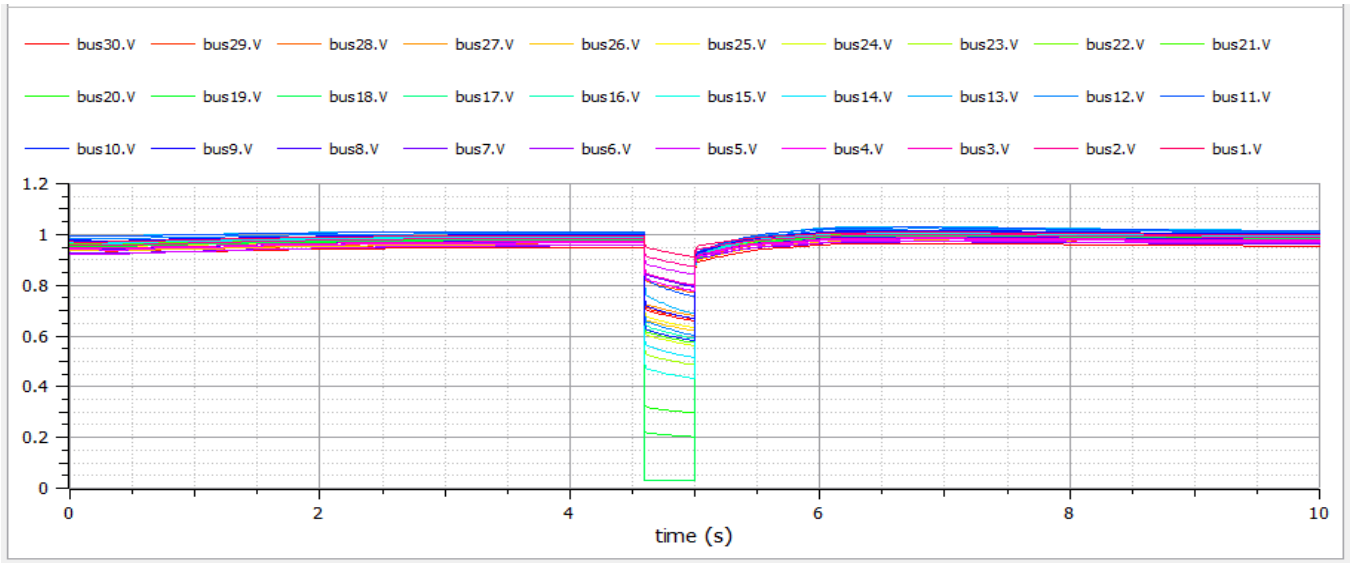


**Figure 3: Voltage profiles of 30 buses**

| Bus no. | Bus Voltage magnitude (p.u.) | Bus no. | Bus Voltage magnitude (p.u.) |
|---|---|---|---|
| 1 | 0.998269 | 16. | 0.997579 |
| 2 | 0.989513 | 17. | 0.993916 |
| 3 | 0.976927 | 18. | 0.982853 |
| 4 | 0.971627 | 19. | 0.980417 |
| 5 | 0.965849 | 20. | 0.984568 |
| 6 | 0.973281 | 21. | 0.990190 |
| 7 | 0.962490 | 22. | 0.991590 |
| 8 | 0.979940 | 23. | 0.988315 |
| 9 | 1.002450 | 24. | 0.991481 |
| 10 | 1.000190 | 25. | 0.981621 |
| 11 | 1.013270 | 26. | 0.964576 |
| 12 | 1.008540 | 27. | 0.983845 |
| 13 | 1.015280 | 28. | 0.971979 |
| 14 | 0.994907 | 29. | 0.964934 |
| 15 | 0.992308 | 30. | 0.954136 |

**Table 2: Bus voltage magnitude (p.u.) of all 30 buses obtained.**

**Conclusion:**

The implemented IEEE modified 30 bus model in Modelica represents the system behavior before and after the fault occurs at the $18^{th}$ bus. Bus voltage magnitude (p.u.) of all modified 30 buses obtained are found to be between 0.9 p.u and 1.1 p.u. The relation between line impedance and fault severity is also observed.