Transient Stability Analysis

Lab 4

EEEN50100 - Stability Analysis of Nonlinear Systems

Exercises

1. Determine the critical clearing time for a fault at bus 7 using a trial-and-error technique for the WSCC 9-bus 3-machine system with classical synchronous machine models. Assume that the fault is cleared by removing the transmission line 5-7.

2. Determine the critical clearing time for a fault at bus 7 using a trial-and-error technique for the WSCC 9-bus system with d-q axis machine models and AVRs. Assume that the fault is cleared by removing the transmission line 5-7. Discuss and compare results of Exercises 1 and 2.

3. Discuss the effect of synchronous machine model and primary controllers on the critical clearing time. With this aim modify the following parameters of the synchronous machines and of their controllers: (i) damping of synchronous machines; and (ii) AVR gain K_a. When increasing AVR gains, check that the system before and after the fault is stable.

4. Discuss the effect on the critical clearing time of a shunt admittance, connected at bus 8. Consider both capacitive and inductive admittances.

Data File

Use the files `wscc_classic.dm` and `wscc_reg.dm` that can be found in the collection of data files on the module website.

Hints

- The time domain integration can be solved using the command:

  ```
  >> dome -r TDS wscc_classic.dm
  ```

  Help on available options can be obtained using the command:

  ```
  >> dome -A TDS
  ```

- Neglect the effect of primary and secondary frequency regulators.

- It is important to check that there exists a stable solution for the system "after" the contingency. This can be easily verified by solving the power flow for the system without line 5-7 and then solving the small-signal analysis.

- For all exercises, set `TDS.pq2z = True`. When solving the small-signal stability analysis, set `SSSA.pq2z = True`.

- It can be convenient to set a fixed time step for the time domain integration: `TDS.fixt = True` and a reasonably small time step, e.g., `TDS.tstep = 0.02`. 5 to 10 seconds of simulated time are sufficient to define the stability of the system and discard first-swing and (likely) multi-swing instability.

- To solve Exercise 4, use the constant shunt admittance device type `Shunt`.

- This is a US network. The system frequency should be set to 60 Hz, e.g., `Settings.freq = 60`.

- The data of the case study `wscc_classic.dm` of this lab activity is based on the following book:

  P. M. Anderson and A. A. Fouad, *Power System Control and Stability*, Second Edition, John Wiley Interscience, 2003.

- The data of the case study `wscc_reg.dm` of this lab activity is based on the following book:

  P. W. Pai and M. A. Sauer, *Power System Dynamics and Stability*, Prentice Hall, 1998.

- Remember to comment out the `Switch` device in the data files.