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Milestone 3B

Repository

Link: https://github.com/griffincj/Power-System-Analysis

Overview

This milestone builds off milestone 3A, completing the power flow solver using the Newton-Raphson algorithm. It also adds functionality to check real and reactive power losses and validate that transmission line currents are within conductor ampacity limits.

The writeup for milestone 3A provides the foundation for the PowerSystem class, and contains more information regarding the methods that create the Jacobians and mismatch vectors.

Main Module

The output required for this module can be displayed by running the main method of the main.py module. The main module runs the run_newton_raphson() method and displays

- Whether the solution converged
- The number of iterations processed
- The details of each bus, including the real and reactive power, voltage angle per unit and voltage magnitude per unit

PowerSystem

The power system class has been extended to add several new methods for solving the power flow problem.

Methods

- Run_newton_raphson(self, iterations)
  - Method updated from milestone 3A to include convergence criteria
- Calc_power_loss(self) and Calc_reactive_loss(self)
  - Calculate loss of system by iterating over all buses and summing their real or reactive powers respectively
  - Results are in per unit. Positive result indicates the amount of excess power needed beyond loads in order to satisfy losses from lines and transformers
- Calc_real_power(self, cur_bus: Bus) and calc_reactive_power(self, cur_bus: Bus)
  - Helper methods to calculate real and reactive power.

    - Used to calculate the real and reactive power of the slack and PV buses upon convergence of the solver
- Calc_ampacity_exceptions(self)
    - Calculates the current flowing through each transmission line in the system
    - Requires the voltage to be solved by the Netwon-Raphson solver
    - I believe this might not be working correctly, just based on the amperages mostly being less than 100.
        - I use |(Va – Vb)/(Z-Series from primitive Y-bus)| which gives me very small values in the tens of thousandths of 1.
        - I multiply this value by 1000 (kA to A) and then by the voltage of each bus (230 for all buses connected via transmission lines) and still get a max amperage of ~150
        - This seems low, but the proportions seem to match the power flow simulation in PowerWorld (i.e. amperages are larger where flows are larger)

PowerWorld Comparison

Pictured is the model in PowerWorld before and after running the Netwon-Raphson solver. This is the same as what was pictured for milestone 3A