EE 5240 - Assignment #5 Due: Fri Feb 26th, 5pm
Spring Semester 2021 - Mork (Extension to Mar 1st)

Objectives: Continued development of MatLab programming skills. Reordering, numerical implementation of Newton-Raphson iterative solution, simple load flow problem.

1) Follow through on Assignment 4 results to verify (and correct if needed) your code that opens and reads an IEEE-standard .cdf file and produces the bus admittance matrix $[Y_{BUS}]$. Reordering is a very useful concept. Matlab has six built-in reordering functions. Four of them are of practical interest in terms of improving the performance of LU factorization. Referring to previous notes on reordering (next-to-last page of "LU, Reordering" on web page), append code to your Matlab program that

   a) Creates a duplicate of $[Y_{BUS}]$ that is reordered according to the desired reordering function,
   b) Uses spy function to display the topology of the resulting reordered system.
   c) For each reordering method, print out the topology (using spy) and the reordering vector, and give a very brief practical explanation of the objective of that particular reordering method.

2) The following "system" of nonlinear equations is to be solved using the Newton-Raphson method. Initial values are $x_1^0 = 1$ and $x_2^0 = -1$.

$$2x_1^2 - 3x_2^2 = 5$$
$$x_1 + 2x_2^2 = 0$$

   a) Set it up in the form $[J^m]\cdot[\Delta x^m] = [\Delta y^m]$ giving the numeric values for the first iteration ($m = 0$).

   b) Calculate $[x]^1$ (the values of x_1 and x_2 resulting from the first iteration).

   c) Continue the iteration until $\| \Delta y \| \leq 0.001$

3) A Newton-Raphson power flow is to be performed on a 3-bus system. Bus 1 is the slack bus. Bus 2 is a PV bus whose generator is producing 0.8 per unit output and has a voltage magnitude of 1.0 per unit. A load of 1.0 + j0.5 is also connected at Bus 2. Bus 3 is a PQ bus having a load of 0.5 + j0.5 per unit. The voltage at bus 3, for the purposes of the first iteration, is assumed to be $V_3 = 1.0\underline{/0}°$ per unit. The admittance matrix is given as

$$Y = \begin{pmatrix} 6.30\underline{/-70.0}° & 6.41\underline{/104}° & 4.70\underline{/97.0}° \\ 6.41\underline{/104}° & 5.90\underline{/-75.0}° & 0.0\underline{/0.0}° \\ 4.70\underline{/97.0} & 0.0\underline{/0.0}° & 8.50\underline{/-65.0}° \end{pmatrix}.$$

   a) How many rows and columns will the Jacobian have? Give the matrix equation that will have to be solved each iteration. (ie. using proper subscripts, tell which partial derivatives must be evaluated, which voltage and angle quantities are the variables, and which ΔPs and ΔQs must be evaluated).

   b) Write the expression for ΔP_2, the net power flowing into bus 2 during the first iteration, and evaluate. What should this value be when the solution has converged? What is ΔP called?

   c) Write the expression for $\partial P_2/\partial \delta_2$ and evaluate for the first iteration.

4) Referring to the IEEE standard 14-bus load flow case, strategize how to form the Jacobian and the vector of ΔP and ΔQ values (hint: learn how to write loops using the matlab FOR construct!).

Coming up next: More on Newton-Raphson, fast decoupled, MatLab programming.