This problem set involves the example power system which was presented in class on February 20, reproduced in Figure 1. We are going to do a few things with this example system, so save your notes.

1. Re-draw the system diagram with all impedances and loads translated to per-unit. Assume that the transformers between 69 and 161 kV buses 15 and 16 at one substation and between buses 9 and 17 at another substation are rated at 150 MVA and that their voltage ratings correspond with the nominal system voltages. You may represent them as purely reactive with $x_t = 8\%$ on their own base. For your per-unit normalization use a system base of 100 MVA and the nominal system voltages (161 and 69 kV). Note, of course, that power called out at each bus is MW+j*MVAR and that voltages are line-line, RMS.

2. Find a 'load flow' solution which includes bus voltages (magnitudes and angles) and line flows. Assume the power plants connected to buses 2 and 3 are producing 220 MW and 70 MVAR (each). Assume that the power plant connected to Bus 1 is providing whatever real and reactive power is required to maintain the system at constant frequency and the voltage at Bus 1 at rated (161 kV). As we will discuss in class, there are multiple ways of computing this load flow. I would suggest doing the calculation using both Gauss-Seidel and Newton-Raphson and comparing the solutions.
Figure 1: Example Power System