

Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science
6.691 Seminar in Advanced Electric Power Systems

Problem Set 6

Issued April 23, 2006
Due May 10, 2006

In this problem set we are going to consider some issues of cost associated with the small example power system you worked on in Problem Set 2. In this we will be asking a few questions which probably do not have 'correct' answers but which do have multiple solutions, some better than others. We are concerned here with the 'energy' cost of electric power.

Assume that the power plant connected to bus 1 (the swing bus for load flow calculations) is rated at 100 MW/125 MVA and that it cost \$40 Million. Fuel and variable operations of this plant costs \$35/MWh. The power plants connected to buses 2 and 3 are capable of 256 MW/320 MVA and cost \$192 Million (each). Fuel and variable operations cost \$25/MWh. For both types of plants reactive power is free. For all of the capital cost calculations assume an interest rate of 12% and a lifetime of 40 years. Base all capital calculations on an average load factor of 70%.

It is possible that you will choose to use capacitors to support voltage (the alternative is to make reactive power with the power plants, which is less expensive but which may produce system losses and unsatisfactory voltage distribution). Capacitors cost \$15/kVAR.

1. Try to establish an 'optimal' dispatch (mix of generation) for this system, which results in minimum total cost of generation for the loads given on Figure 1. Make sure that all voltages are within 5% of nominal and that all power plants are within their limits. It is here that you may consider using capacitors for voltage support. Don't worry about overloading lines – we have plenty of capacity there.
2. Now, under cost based regulation, what is the price per kWh to the customer? (That is, for generation cost only – cost for use of the T&D network is beyond our scope here), but include the cost of power factor correction (voltage support) capacitors if you used them.

Loads MW + j MVAR
 Impedances in Ohms R + jX
 ——— 161 kV
 - - - 69 kV

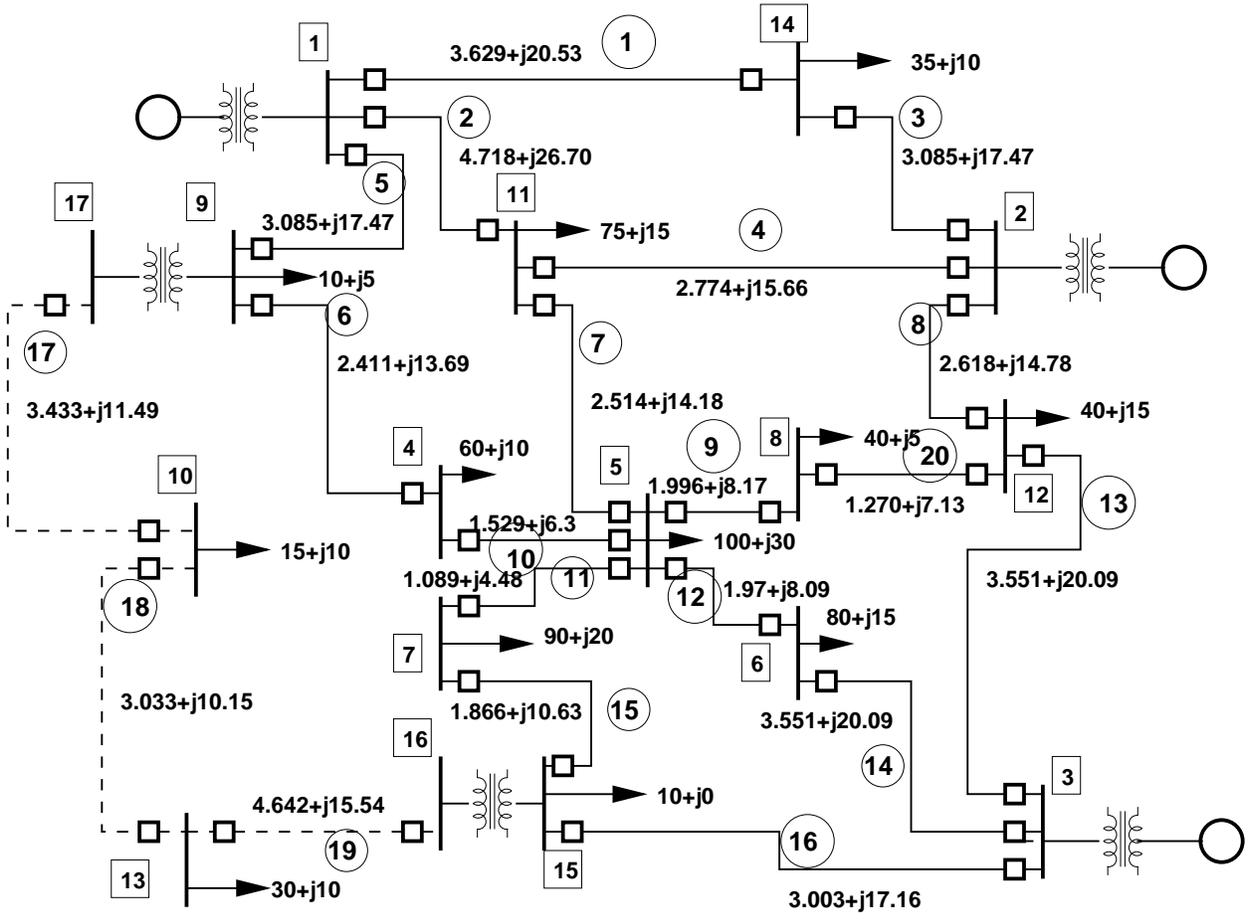


Figure 1: Example Power System