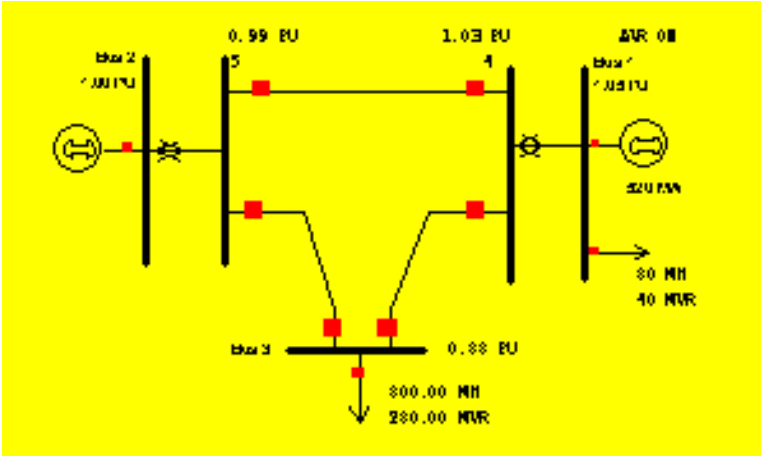
Five Bus System Homework Assignment

Thanks to Prof. Chen-Ching Liu and Ph.D. Candidate Madeleine Gibescu of the University of Washington for this problem set.

Download the cases needed for the Assignment (PW Simulator 5.0 or later format)

A one line diagram, together with the bus and line data, of a 5-bus power system is shown below; the system will be referred to as utility A. Solve the following problems using thePowerWorld Simulator and the original data file 454_0.pwb and the one-line diagram file 454_0.pwd.

1. For the power system of utility A, use the PowerWorld program to find the MVAr rating of a shunt capacitor at bus 3 that increases V3 to 1.00 p.u. Determine the effect of the capacitor bank on the line loading and total I2R losses.
2. Run the original power flow for utility A. Do you find any voltage violations? (The normal range of bus voltages is assumed to be 0.95-1.05 p.u.) Now suppose both transformers in this system are tap changing transformers whose taps can be varied from 0.85 to 1.15 p.u. in increments of 0.05 p.u. Determine the tap settings required to increase the voltage at bus 3 to 0.95 p.u., while causing as few high voltage violations as possible at the other buses.
3. A new transformer is installed between buses 2 and 5, in parallel with the existing transformer between buses 2 and 5. The new transformer is identical to the existing transformer. The taps on both transformers are set to the nominal value, 1.0 p.u. Find the real power, reactive power and MVA supplied by each of these transformers to bus 5.
4. Refer to the one-line diagram of utility A. Suppose an additional line is installed between buses 3 and 4. The line parameters of the added line are equal to those of the existing line 3-4. Determine the effects on the voltage at bus 3, line loading and total I2R losses.
5. In problem 2 you already ran the power flow for utility A and detected low voltage violations. Place a capacitor at bus 3 to bring the bus 3 voltage up to 0.95 p.u. Determine the size of the capacitor bank. Now suppose the line between buses 3 and 5 is removed for maintenance. Run the power flow again. Is the operating condition acceptable? If not, determine the amount of load you have to shed at bus 3 in order to maintain the bus 3 voltage above 0.95 p.u. Cut the same percentage of MW and MVAr at bus 3.



Initial Bus Records

Bus	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load MVR	Gen MW	Gen MVR
1	1.05000	15.75	-0.500	80.00	40.00	520.00	238.94
2	1.00000	15.00	0.000			390.70	26.16
3	0.87580	302.15	-21.256	800.00	280.00		
4	1.02871	354.90	-2.755				
5	0.99196	342.23	-4.495				

Line Records (Base MVA = 400)

From	To	Xfrmr	R	X	B	MVA Lim
4	1	Yes	0.00300	0.04000	0.00	1000.0
2	5	Yes	0.00600	0.08000	0.00	600.0
4	3	No	0.03600	0.40000	0.44	1200.0
5	3	No	0.01800	0.20000	0.44	1200.0
4	5	No	0.00900	0.10000	0.22	1200.0