Power System Analysis I *** Midterm II ***Fall**** December 17, 2010

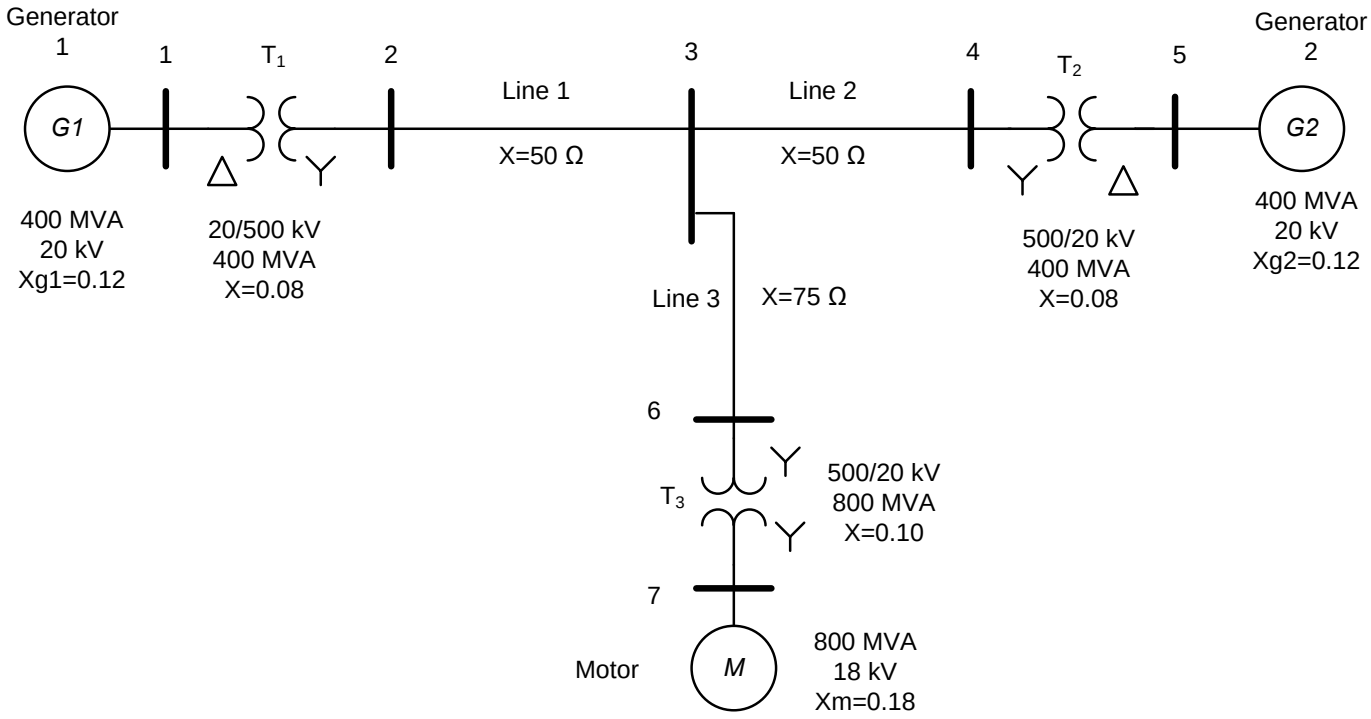
1(35): A 70-km, 230-kV, 60Hz three-phase overhead transmission line has a positive-sequence series impedance of $\bar{z} = 0.08 + j0.48\ \Omega/\text{km}$ and positive sequence shunt admittance $\bar{y} = j3.33 \times 10^{-6}\ \text{S/km}$. At full load, the line delivers 250 MW at 0.99 power factor lagging and at 220 kV. Using the short line model, calculate the following:

- **a)** ABCD parameters of the line
- **b)** The sending-end voltage and current
- **c)** The percent voltage regulation
- **d)** The sending-end real power and reactive power
- **e)** The real and reactive power lost in the line.

2(35): The figure below shows the one-line diagram of a three-phase power system.

a) Draw the per-unit impedance diagram of the system including the transformer phase shifts. Use the ratings of the generator 1 as the base values.

b) The motor is drawing 700 MVA from the system at the rated terminal voltage and at 0.8 power factor lagging. Determine the voltages at bus 1 and bus 5 in per-unit and also in kV. Assume that generators 1 and 2 supply equal real powers and equal reactive powers.



$$Z_{new} = Z_{old}\left(\frac{V_{baseold}}{V_{basenew}}\right)^2\left(\frac{S_{basenew}}{S_{baseold}}\right) \qquad I_{base} = \frac{S_{base1\phi}}{V_{baseLN}} = \frac{S_{base3\phi}}{\sqrt{3}V_{baseLL}} \qquad Z_{base} = \frac{V_{baseLN}}{I_{base}} = \frac{V^2{}_{baseLN}}{S_{base1\phi}} = \frac{V^2{}_{baseLL}}{S_{base3\phi}}$$

Duration of the exam is 80 minutes

3(30): A single-phase two-winding transformer has the following ratings:
150 kVA, 300 V/600 V, and a total series leakage reactance of 8.4%.
If the given transformer is connected as a step-up autotransformer,

- **a)** Determine the voltage and power rating as an autotransformer
- **b)** Draw the circuit schematic of the autotransformer.
- **c)** Find the per-unit leakage reactance for the high voltage terminal as an autotransformer.