POWER SYSTEM ANALYSIS I Midterm II December 10, 2009

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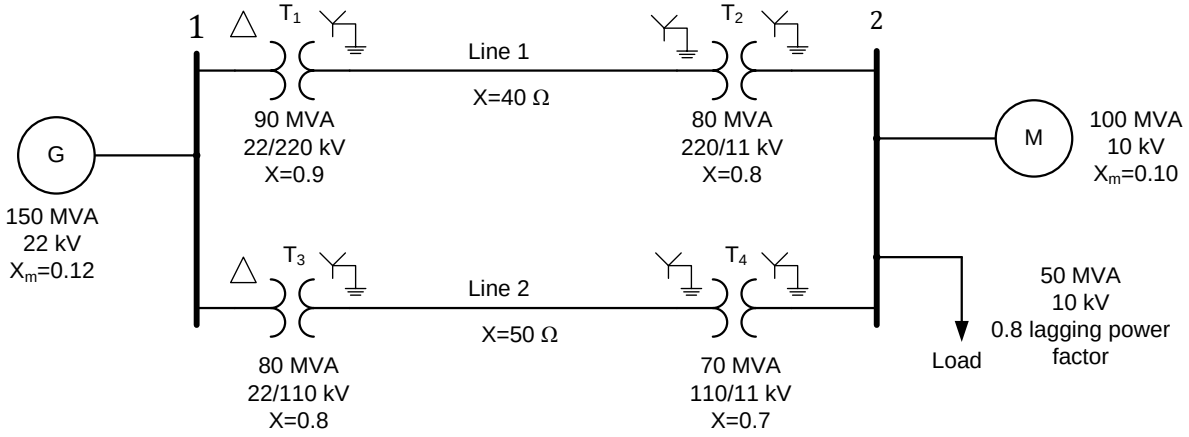
Student name *Number:*

P1 (35): The figure below shows the one-line diagram of a three-phase power system. The load as shown in the figure draws 50 MVA at 10 kV and 0.8 lagging power factor.



a) By selecting a common base of 100 MVA and 10 kV on **bus number 2**, draw the per-unit impedance diagram of the system including the load impedance in per-unit. Include the transformer phase shifts in the diagram, but ignore the R and the excitation branch.

b) Find the current supplied by the generator in per-unit and also in Amperes when the motor operates at full load, at 0.7 power factor lagging, and at terminal voltage of 10 kV. Include the phase shifts of the transformers.

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

$$Z_{base} = \frac{V_{baseLN}}{I_{base}} = \frac{V^2{}_{baseLN}}{S_{base1\phi}} = \frac{V^2{}_{baseLL}}{S_{base3\phi}}$$

P2 (10): Make a step-up autotransformer using a 120 kVA, 20/60 kV single-phase two-winding transformer.

a) What is the voltage at the high voltage side of the autotransformer?

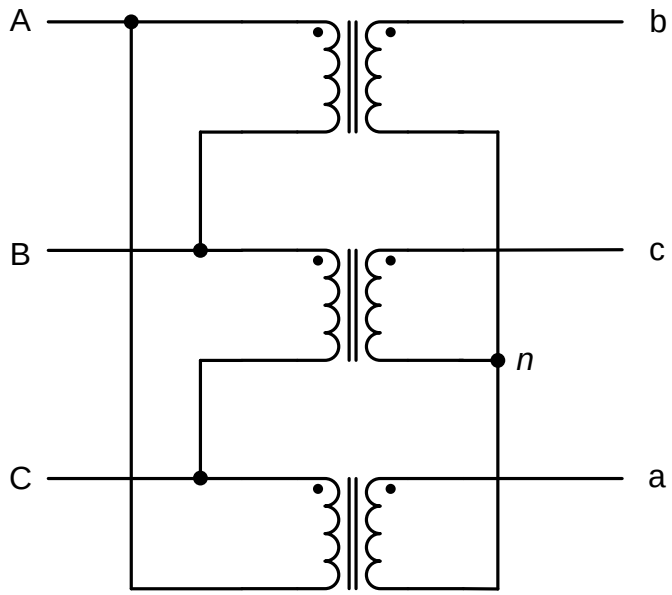
b) What is the kVA rating of the autotransformer?

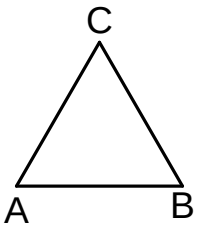
Duration of exam is 85 minutes

P3 (30): The following schematic shows a Δ / Y connected three-phase transformer.

a) Draw the phasor voltage diagram for the low-voltage side and find the phase shift between V_{AN} and V_{an}. Assume that the phasor voltages shown in the Figure below are applied to the high-voltage side windings.

b) For the same input, reconnect and/or give new labels to the low-voltage side terminals so that V_{an} lags V_{AN} by 30º.





P4 (25): A 180 km, 220 kV, 60 Hz three-phase over head transmission line has the following line constants.

$$\bar{z} = (0.02 + j0.32)\ \Omega/km, \qquad \bar{y} = j4 \times 10^{-6}\ \mathrm{S}/km$$

The three-phase load at the receiving-end absorbs 600 MW at 0.85 lagging power factor at 96 % of rated voltage.

a) Calculate the ABCD parameters of the line.
b) Draw the nominal-π circuit model
c) The sending-end voltage and the current.
d) Sending-end total real and reactive power.

$$\overline{\mathrm{A}}=\overline{\mathrm{D}}=\left(1+\frac{\overline{\mathrm{YZ}}}{2}\right) \qquad \overline{\mathrm{B}}=\overline{\mathrm{Z}} \qquad \overline{\mathrm{C}}=\overline{\mathrm{Y}}\left(1+\frac{\overline{\mathrm{YZ}}}{4}\right)$$