Power System Analysis I *** Midterm II ***Summer School**** August 11, 2010

Name *Number:*

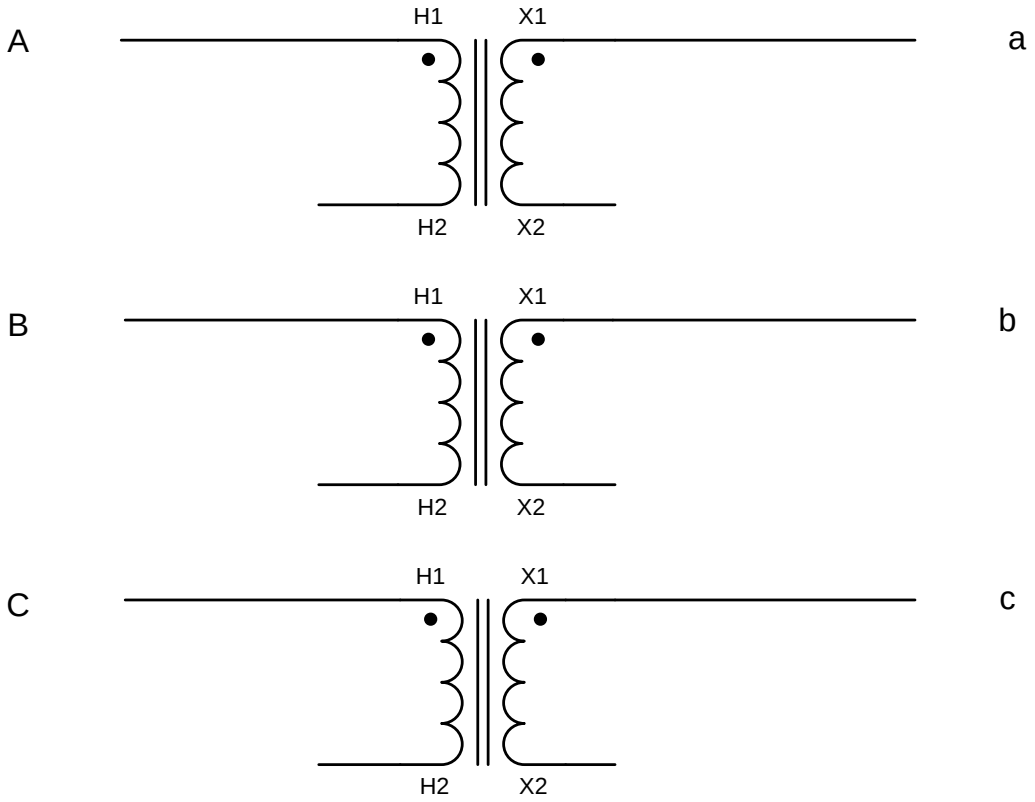
Signature:

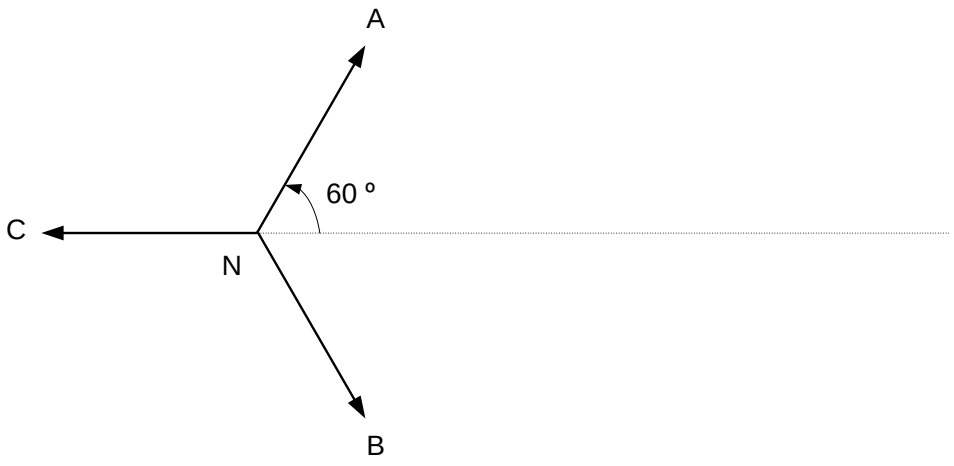
P1 (35): The following schematic shows three identical single-phase two-winding transformers. Using these single-phase transformers, we want to construct a three-phase transformer bank. Assume positive-sequence balanced three-phase system.

a) Connect the high-voltage side as **Y** and low-voltage side as Δ.

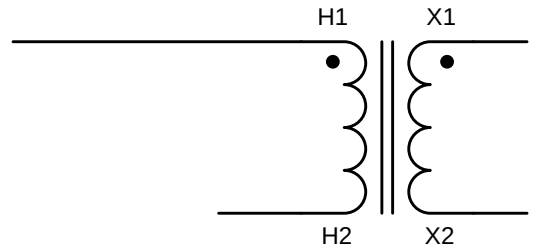
b) Assuming that the phasor voltages shown in the Figure below are applied to the high-voltage side windings, draw the phasor voltage diagram for the low-voltage side and find the phase shift between V_{AN} and V_{an}.

c) For the same input, reconnect and/or relabel the low-voltage terminals so that V_{an} leads V_{AN} by 150º.

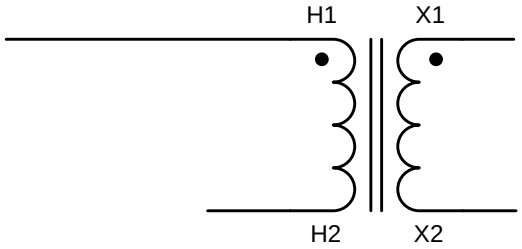




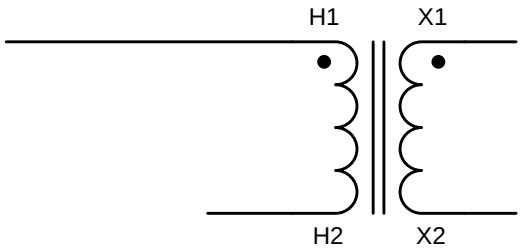
A



B



C



P2 (20): A 600 MVA, 50 Hz, and 500 kV/69 kV three-phase transformer with 10% leakage reactance will be installed in a substation. The transformer windings are connected in Y / Y configuration. Assume that the high voltage terminals are connected to an ideal bus at 500 kV and draw 2 per-unit current at 0.8 lagging power factor.

a) Find the voltage at the low-voltage windings in kV. Use the transformer ratings as base values.

b) According to the regulation criteria, the voltage at the low-voltage bus should be above 0.95 per-unit. What should be done to satisfy this condition?

P3 (30): **(a)** The figure below shows the one-line diagram of a three-phase power system. Draw the per-unit impedance diagram of the system including the transformer phase shifts. Use the 500 MVA and 20 kV as the base values at the generator side.

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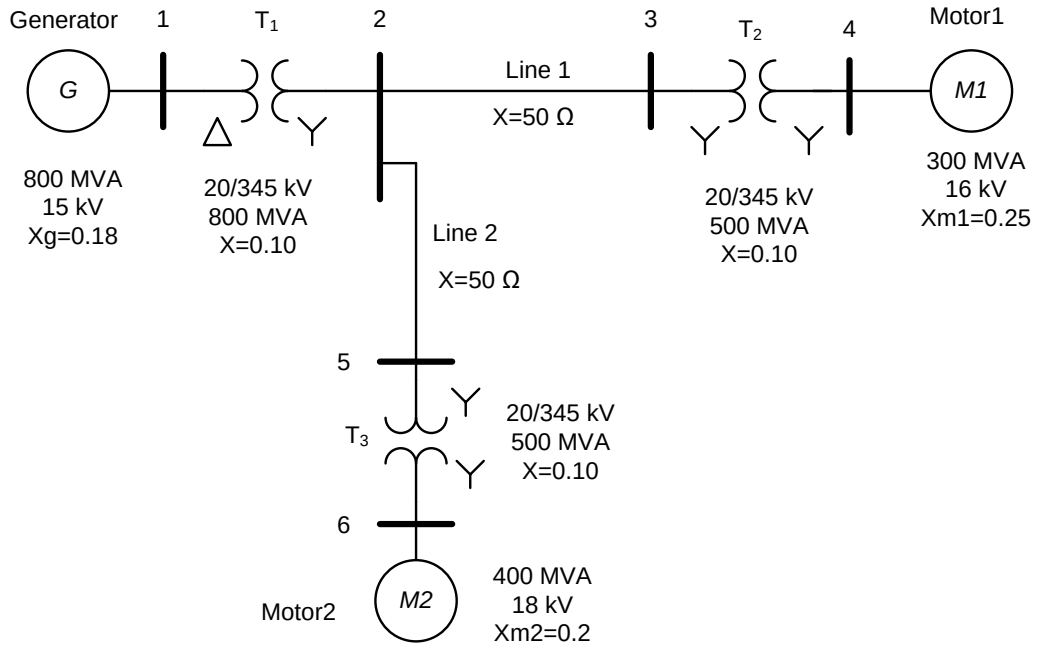

$$Z_{new} = Z_{old}\left(\frac{V_{baseold}}{V_{basenew}}\right)^2\left(\frac{S_{basenew}}{S_{baseold}}\right) \qquad I_{base} = \frac{S_{base1\phi}}{V_{baseLN}} = \frac{S_{base3\phi}}{\sqrt{3}V_{baseLL}} \qquad Z_{base} = \frac{V_{baseLN}}{I_{base}} = \frac{V^2{}_{baseLN}}{S_{base1\phi}} = \frac{V^2{}_{baseLL}}{S_{base3\phi}}$$

(b) (15): The motors M_1 and M_2 in the problem 1 are drawing their rated powers from the system at the rated terminal voltages. In addition, the both motors are operating at 0.8 lagging power factor. Find the current supplied by the generator in per-unit and in Amperes.