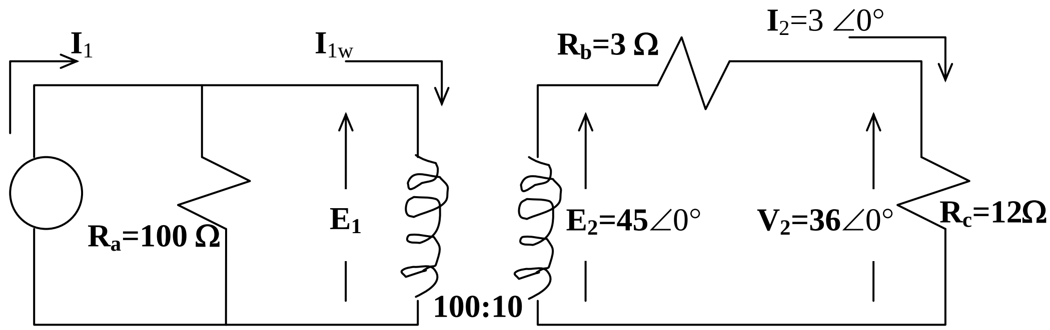
Name:____

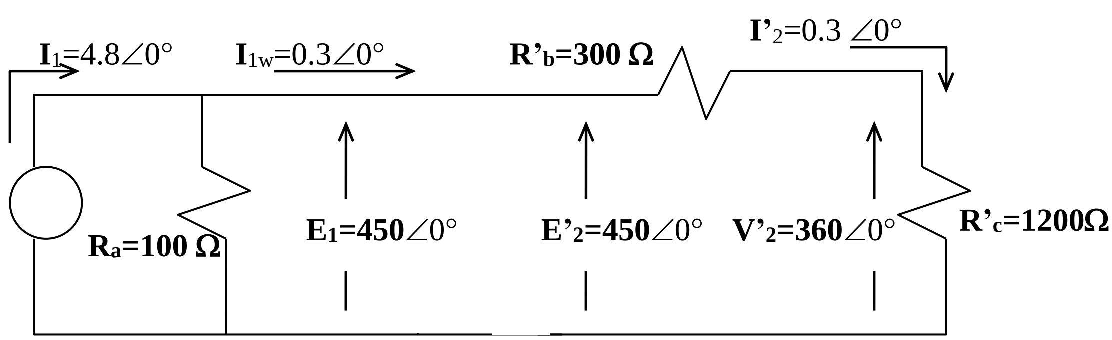
EE 303, Quiz 4, Spring, 2019, Dr. McCalley
20 minutes, closed book, closed notes, calculator allowed, no communication devices

1. (30 pts) Answer the following questions considering the "exact" equivalent model for a transformer.
   a. What element or elements model the leakage flux? ___X_1 and X_2______
   b. What element or elements model the real power losses caused by eddy currents in the transformer core?__R_c__________
   c. What element or elements model the hysteresis losses in the transformer core?______R_c______
   d. What element or elements model the real power losses caused by I^2R effect in the windings?______R_1 and R_2_______
   e. What element or elements model the reactive power associated with setting up the magnetizing flux in the core?______X_m_____
   f. If you wanted to represent this transformer in a large-scale study of the power system where you are mainly concerned about the network voltage profile, what are the two most important elements of the model? ______ X_1 and X_2_______

2. (40 pts) In the circuit below, the primary turns is N_1=100 and the secondary turns is N_2=10. Refer all of the numerical quantities indicated over to the primary side and draw the primary-side circuit you would use for analysis. Label the resistant elements appropriately and give their values. Also label the following phasor quantities on your diagram, and for each one, give the corresponding numerical value: $\mathbf{V}_2', \mathbf{E}_2', \mathbf{I}_2', \mathbf{E}_1, \mathbf{I}_{1w}, \mathbf{I}_1$.

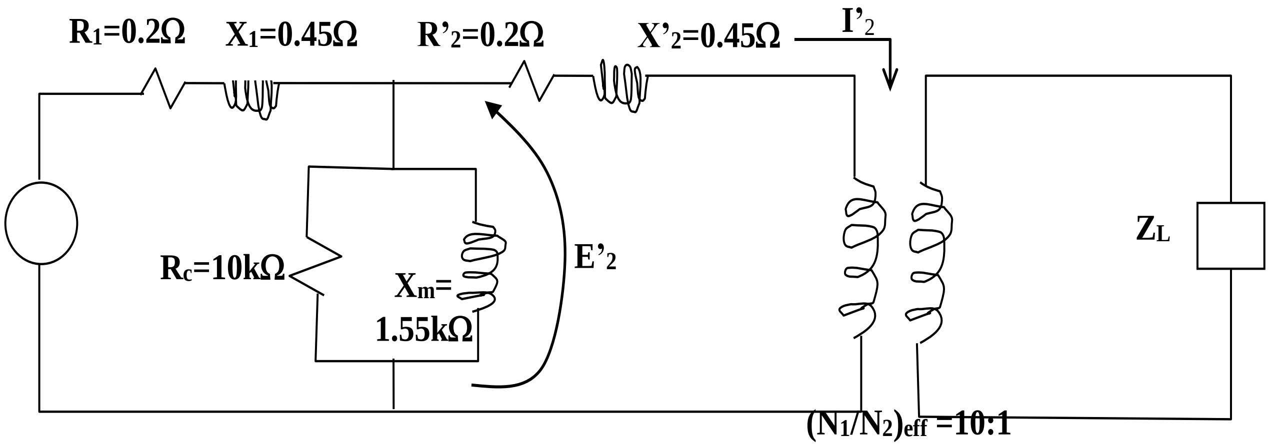


Solution:



3. (30 pts) The "exact" equivalent circuit parameters of a 150-kVA, 2400volt/240volt single-phase transformer are R_1=0.2Ω, R_2=2mΩ, X_1=0.45Ω, X_2=4.5mΩ, R_c=10kΩ, and X_m=1.55kΩ. R_1, X_1, R_c, and X_m are given referred to the primary side; R_2 and X_2 are given referred to the secondary side. A company purchases three of these single-phase transformers and connects them in a Y-Y configuration to a three-phase Y-connected load Z_L.
   a. Draw per-phase "exact" equivalent of the circuit (transformer and load) with all elements, except the load, referred to primary side.
   b. Label all impedance elements on the diagram with their ohmic value (use letters and numerical value).
   c. Identify on the diagram the turns ratio $(N_1/N_2)_{eff}$ to be used in the per-phase circuit (identify numerical value).
   d. Label the secondary current referred to the primary, $\mathbf{I}'_2$ (do not need numerical value, just location & directionality).
   e. Label the voltage across the secondary winding, referred to the primary, $\mathbf{E}'_2$ (do not need numerical value, just location & directionality).

   Solution:



f. What would be the effective turns ratio $(N_1/N_2)_{eff}$ (give a numerical ratio) in the per-phase circuit if the transformers were connected Y-Δ?

Solution:

$$(N_1 / N_2)_{eff} = \frac{N_1}{N_2}\sqrt{3}\angle 30° = \frac{10}{1}\sqrt{3}\angle 30° = 17.32\angle 30°$$