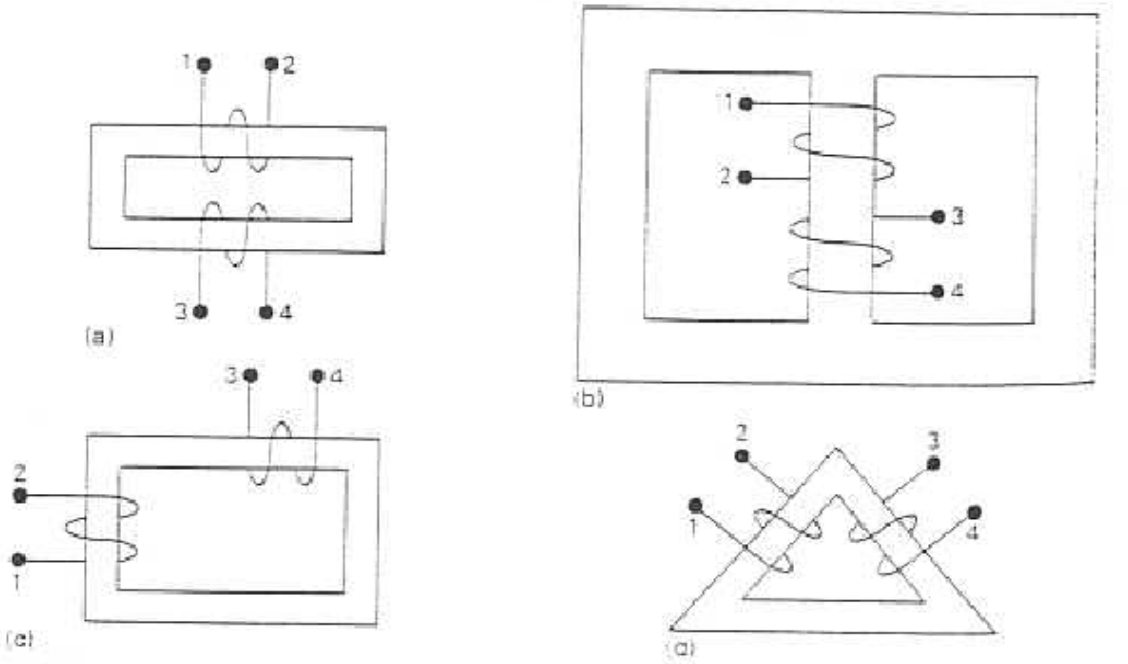
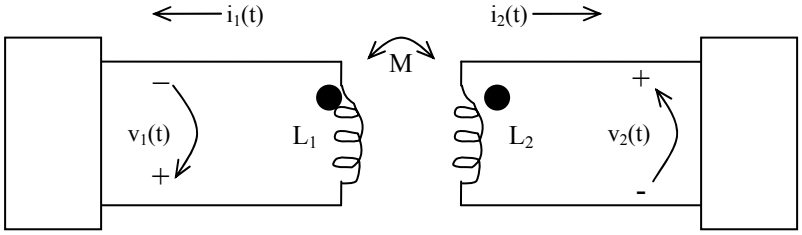
EE 303 Homework on Transformers, Dr. McCalley.

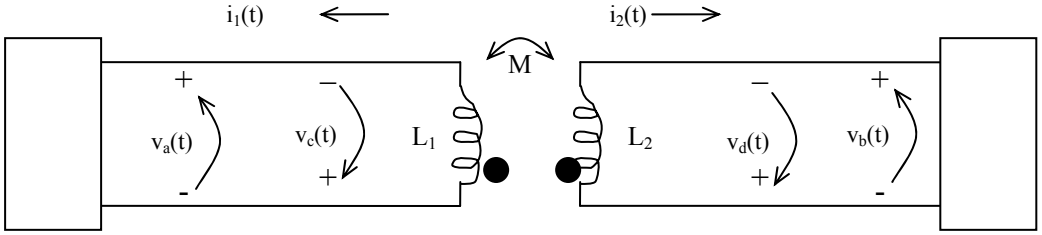
1. The physical construction of four pairs of magnetically coupled coils is shown below. Assume that the magnetic flux is confined to the core material in each structure (no leakage). Show two possible locations for the dot markings on each pair of coils.



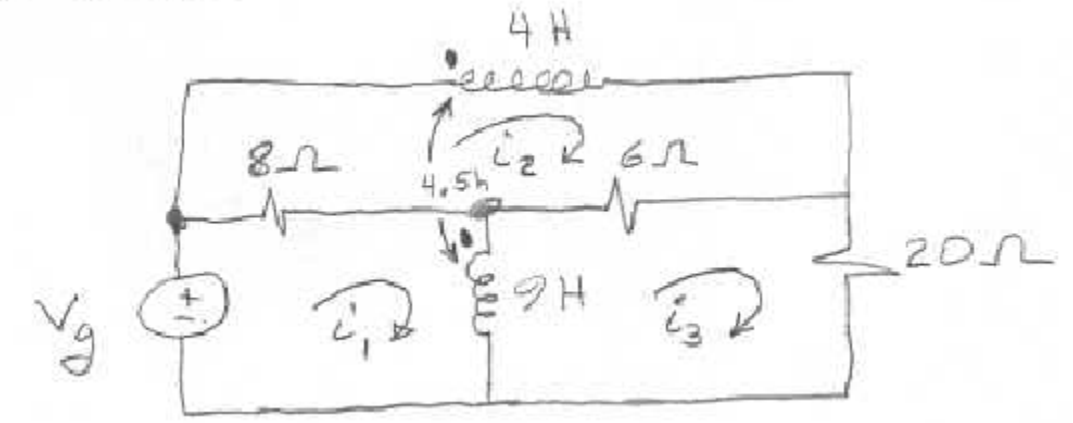
2. Write the equations for $v_1(t)$ and $v_2(t)$ for the circuit below.



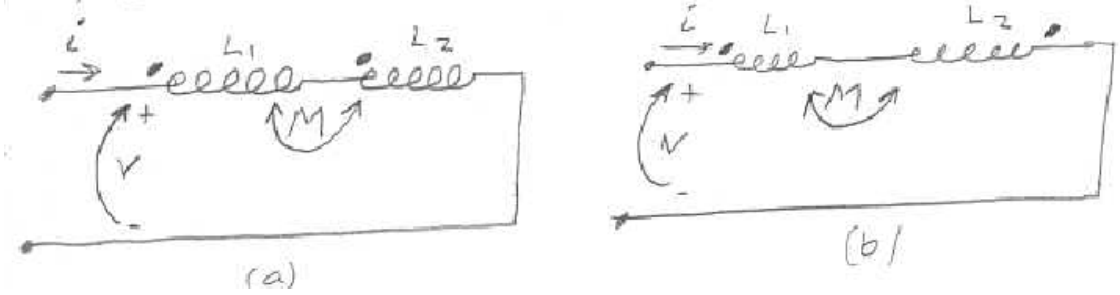
3. Write the equations for (a) $v_a(t)$ and $v_b(t)$ and (b) $v_c(t)$ and $v_d(t)$ for the circuit below.



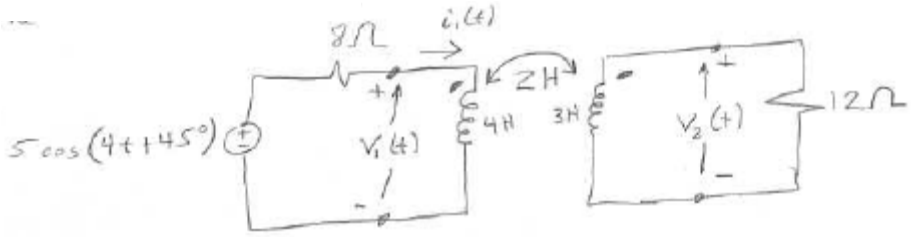
4. Write a set of mesh current equations that describe the circuit below in terms of i_1, i_2, and i_3.



5. A pair of coupled inductors is connected in two different ways as shown below. In each case, find the differential equation relating v(t) and i(t), and then find the equivalent inductance "seen" at the terminals looking into the circuit.



6. Use phasors to find the voltage $v_2(t)$ in the circuit below.

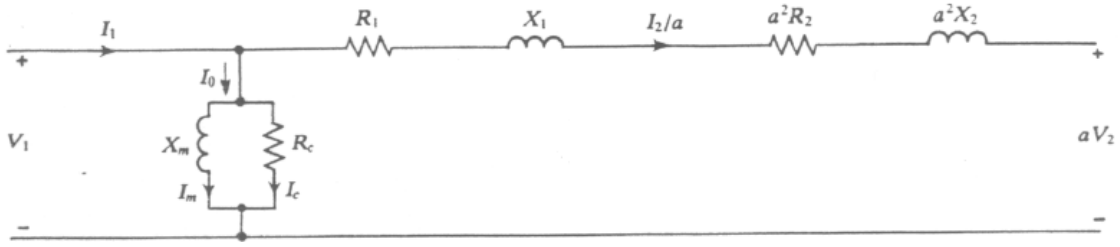


7. The ohmic values of circuit parameters of a transformer, having turns ration of $N_1/N_2=5$, are $R_1=0.5\Omega$, $R_2=0.021\Omega$, $X_1=3.2\Omega$, $X_2=0.12\Omega$, $R_c=350\Omega$, and $X_m=98\Omega$. (R_1, X_1, R_c, and X_m are given referred to the primary side; R_2 and X_2 are given referred to the secondary). Draw the approximate equivalent circuit of the transformer, with all quantities referred to (a) the primary and (b) the secondary. Show the numerical values of the circuit parameters.

8. The "exact" equivalent circuit parameters of a 150-kVA, 2400volt/240volt transformer are $R_1=0.2\ \Omega$, $R_2=2m\Omega$, $X_1=0.45\Omega$, $X_2=4.5m\Omega$, $R_c=10k\Omega$, and $X_m=1.55k\Omega$. (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). Using the circuit referred to the primary, determine the (a) percent voltage regulation and (b) efficiency of the transformer operating at rated load (150 kVA) with 0.8 lagging power factor. Assume that V_2=240 volts and note that percent voltage regulation is given by $(V_{no\text{-}load}-V_{load})/V_{load}$ (where these are voltage magnitudes).

9. Using the "approximate equivalent circuit #1", shown below, repeat the calculations of problem 8 and compare the results (note that "a" is the turns ration N_1/N_2).



10. The coefficient of coupling for coupled coils is defined as

$$k = \frac{M}{\sqrt{L_{11}L_{22}}}$$

(a) Show that the idea case of no-leakage flux results in k=1.
(b) Determine for the actual case, where leakage flux exists, whether k>1 or k<1.
(c) The coupled circuit below has a coefficient of coupling of 1, We wish to determine the energy stored in the mutually coupled inductors at time t=5 msec, where L_{11}=2.653 mH and L_{22}=10.61 mH.