Homework # 3

Due: Tuesday, June 20th

Question 1. a. (10 points) Why air-core transformers do not saturate?

Air isn't ferromagnetic. Ferromagnetic materials eventually hit a point where increased flux density doesn't pass thorough and it saturates, but air cores let all flux through and avoid saturation

b. (10 points) What are the similarities between electric and magnetic circuits.

One uses the electric field, one uses the magnetic field, so they're analogs to eachother in many ways. Conductivity is permeability, resistance is reluctance, EMF is MMF, current is flux, etc...

c. (10 points) Explain the advantages and applications of autotransformers.

In applications where the ration is close to 1, you can electrically connect the coils like a potentiometer. They have higher poewr ratings since they use conduction as well, they're small, efficient, and have low internal impedance. Common applications are converting between domestic mains voltages.

Question 2. (35 points) A transformer's max. efficiency is 0.99 at 16 kVA, unity power factor. Calculate its all-day efficiency for a day's loading as given below.

10 hours : 4 kW at 0.75 p.f., lag
8 hours : 12 kW at 0.85 p.f., lag
6 hours : 18 kW at 0.92 p.f., lag

constant copper loss

max Input(at max efficiency)=16k/.99=16161W, loss=161W
current load=16k*pf*portion, portion=current load/(16k*pf)
portion1=4k/(16k*.75)=.33 output1=10*4k=40k
portion2=12k/(16k*.85)=.88 output2=8*12k=96k
portion3=18k/(16k*.92)=1.22 output3=6*18k=108k
copper loss=161/2*24=1.939k
244k/(244k+1.939k+.841k)=98.87%

Question 3. (35 points) A 60 kVA, 4.4kV/230 V transformer has a primary resistance of 2.25 ohm and a secondary resistance of 0.01 ohm. The values of corresponding reactances are 6.1 ohm and 0.02 ohm. Calculate the following

(a) equivalent resistance and reactance as referred to primary
(b) equivalent resistance and reactance as referred to secondary
(c) equivalent impedance as referred to both primary and secondary

Prim I at full load = I1=60000/4400=13.64A
Sec I at full load = I2=60000/230=260.87A
K=230/4400=.0523
a) R1 + R2/K^2
equiv resistance ref to prim = 2.25+.01/.052^2=5.95ohms
equiv reactance ref to prim = 6.1+.02/.052^2=13.5ohm
b)
equiv resistance ref to sec = .01+2.25*.052^2=0.016ohm
equiv reactance ref to sec = .02+6.1*.052^2=0.037ohm
c)
equiv impedance ref to prim = sqrt(5.95^2+13.5^3)=14.75ohm
equiv impedance ref to sec = sqrt(.016^2+.037^2)=0.04ohm