KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

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EE 360

MAJOR EXAM # 1

October 20, 2005

1:30 – 2:30 pm

Key Solution

Section:

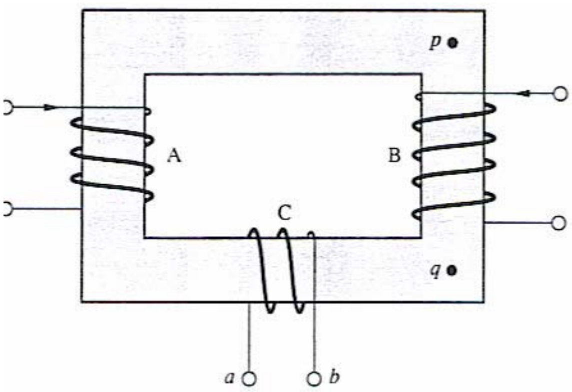
Student Name:

Student I.D.#

Serial #

Question # 1	
Question # 2	
Total	

Q. 1) The magnetic circuit shown below has a uniform cross-sectional area of 5 X 10^{-4} m^2 and a mean length of 0.4 m. Three coils (A, B, C) are wound on the cast steel core. Coil A has 200 turns and carries a current of 0.5 A. Coil B has 400 turns and carries a current of 0.75 A. Coil C has 100 turns. The relative permeability of the ferromagnetic material is 950.
a) Determine the **magnitude** and **direction** of the current flowing in coil C in order to produce a magnetic flux of 0.45 X 10^{-3} webers in a **counterclockwise** direction.
b) What should be the **magnitude** and **direction** of the current flowing in coil C in order to reverse the direction of the magnetic flux produced in part (a).



(50 Marks)

Solution:

a) From Amper's Law

$$200 * (0.5) + 400 * (0.75) + 100 * I_c = - \frac{0.4}{950 * 4 * \Pi * 10^{-7} * 5 * 10^{-4}} * 0.45 * 10^{-3}$$

I_c = - 7 A (i.e., Coil C should carry a current of 7 A entering terminal "a")

b) I_c = - 1 A (i.e., Coil C should carry a current of 1 A entering terminal "a")

Q. 2) A 15-kVA, 2400/240 V, transformer has a series equivalent impedance of Z_{e1} = 6 + j 8.5 Ohm referred to the high voltage side. The shunt magnatizing branches are R_{c1} = 50 kOhm, and X_{m1} = 15 kOhm referred to the high voltage side.
a) If the transformer delivers rated current to a load at 240 V and 0.8 lagging power factor, calculate the primary voltage of the transformer referred to the high voltage side.
b) If the transformer delivers rated current to a load at 240 V and 0.8 lagging power factor for 12 hours, and delivers 75% of the rated current to the same load for the remaing 12 hours. Calculate the daily kilowatthour energy consumbtion by the load.

(50 Marks)

Solution:

a) $V_2 = 240\ \angle 0^o$ V (or $V_2^{'} = 2400\ \angle 0^o$ V)

$I_2 = \frac{15000}{240}\angle -\cos^{-1} 0.8 = 62.5\angle -36.9^o$ A (or $I_2^{'} = 6.25\angle -36.9^o$ A)

Cosidering the excitation branch between the secondary voltage and Z_{eq}

$I_1 = 6.25\angle -36.9^o + (2400\ \angle 0^o)*(\frac{1}{50000} + j\frac{1}{15000}) = 5.046 - j\,3.913 = 6.385\angle -37.8^o$ A

$V_1 = 2400\ \angle 0^o + (6.385\angle -37.8^o)*(6 + j\,8.5) = 2463.6\angle 0.45^o$ V

OR cosidering the excitation branch between the primary voltage and Z_{eq}

$V_1 = 2400\ \angle 0^o + (6.25\angle -36.9^o)*(6 + j\,8.5) = 2462\angle 0.47^o$ V

b) Load Energy = (12)*(240)*(62.5)*(0.8) + (12)*(240)*(0.75*62.5)*(0.8)

= 144 + 108 = 252 kWh