ECE 320 / ECE 329 NAME ______________________

Quiz #4 13 February 2012

Transformers Lesson 14

1. (3 points) Ideal Transformer. A small transformer rated at 250VA, 930V:120V provides power to a 200 Watt, 120V AC rms lighting load. If the load is entirely resistive, find the input current of the transformer. Use an ideal transformer assumption.

B

a. 1.67 Amps
b. 0.215 Amps
c. 7.75 Amps
d. 0.129 Amps
e. Other ______________

$N_T := \frac{930}{120} = 7.75$ $V_2 := 120 \cdot V$ $P_2 := 200 \cdot W$

$I_2 := \overline{\left(\frac{P_2}{V_2 \cdot 1.0}\right)} = 1.667\ A$

$I_1 := \frac{I_2}{N_T} = 0.215\ A$

Alternate method

$R_1 := N_T^{\ 2} \cdot \frac{V_2}{I_2} = 4.324 \times 10^3\ \Omega$ $I_1 := \frac{930 \cdot V}{R_1} = 0.215\ A$

2. (3 points) For the same small ideal transformer rated at 250VA, 930V:120V, determine the input electrical power.

A

a. 200 Watts
b. 1.55 kW
c. 25.8 Watts
d. 250 VA
e. Other ___________

For an ideal transformer, power in equals power out. $P_{in} := P_2 = 200\ W$

3. (3 points) One of the problems with autotransformers is that they tend to get rather hot at the bottom end of the coil, particularly when the tap setting is close to the bottom of the coil. For 120V and 2.0A AC rms input, determine the output voltage and current of an autotransformer when the tap is 15% above the lower end of the coil.

C

a. 15.3 Amps
b. 2.0 Amps
c. 13.3 Amps
d. 11.3 Amps
e. Other ______________

$V_{3in} := 120 \cdot V$ $I_{3in} := 2.0 \cdot A$ $S_{3in} := V_{3in} \cdot \overline{I_{3in}} = 240 \cdot V \cdot A$ $tap := 15 \cdot \%$

Find the output current first.

$S_{3out} := S_{3in} = 240 \cdot V \cdot A$ $V_{3out} := tap \cdot V_{3in} = 18\ V$

$I_{3out} := \frac{S_{3out}}{V_{3out}} = 13.333\ A$

By KCL, the current on the bottom of the coil is

$I_{bottom} := I_{3out} - I_{3in} = 11.333\,A$

4. (3 points) A transformer rated at 1.0MVA, 12kV:480V is given an open circuit test. Its parameters are given as:

5.7 Ohms	Series resistance referred to the high voltage side
22.8 Ohms	Series leakage reactance referred to the high voltage side
20.0 Ohms	Parallel magnetizing reactance referred to the low voltage side
80 Ohms	Parallel core loss resistance referred to the low voltage side

If the test is performed according to procedures in the textbook, what should we expect for current reading that we record?

C

a. 3.2 Amps
b. 510 Amps
c. 24.7 Amps
d. 618 Amps
e. Other ________________

$j := \sqrt{-1}$

$S_3 := 10^6 \cdot V \cdot A \qquad V_0 := 480 \cdot V$

$R_{1H} := 5.7 \cdot \Omega \qquad X_{1H} := 22.8 \cdot \Omega \qquad X_{ML} := 20 \cdot \Omega \qquad R_{CL} := 80 \cdot \Omega$

$$I_{OC} := \left| \frac{V_0}{R_{CL}} + \frac{V_0}{j \cdot X_{ML}} \right| = 24.739\,A$$

5. (8 points) A 1.0 MVA, 13.8kV: 1kV transformer has the following parameters:

5.7 Ohms	Series resistance referred to the high voltage side
22.8 Ohms	Series leakage reactance referred to the high voltage side
20.0 Ohms	Parallel magnetizing reactance referred to the low voltage side
150 Ohms	Parallel core loss resistance referred to the low voltage side

a. (2 points) Draw an appropriate equivalent circuit for this transformer and label each circuit element.
b. (6 points) For a load of 0.15 Ohms, find the input current.

$S_5 := 10^6 \cdot V \cdot A \qquad V_{5L} := 1 \cdot kV \qquad R_{5L} := 0.15 \cdot \Omega \qquad N_5 := \frac{13800}{1000} = 13.8$

$R_{1H} := 5.7 \cdot \Omega \qquad X_{1H} := 22.8 \cdot \Omega \qquad X_{ML} := 20 \cdot \Omega \qquad R_{CL} := 80 \cdot \Omega$

$$Z_{5L} := \frac{1}{\frac{1}{j \cdot X_{ML}} + \frac{1}{R_{CL}} + \frac{1}{R_{5L}}} = \left(0.15 + 1.121i \times 10^{-3}\right)\Omega \qquad Z_{5H} := N_5^{\,2} \cdot Z_{5L} = (28.511 + 0.213i)\,\Omega$$

$$I_{5H} := \frac{13800 \cdot V}{Z_{5H}} = (483.998 - 3.623i)\,A \qquad \left|I_{5H}\right| = 484.011\,A \qquad \arg\left(I_{5H}\right) = -0.429 \cdot deg$$