Name_____ ECE 3600 Homework 8 Non-Ideal transformers c

1. The parameters of a step-down transformer are shown below. Due: Tue, 9/24/24
The transformer is loaded with $\mathbf{Z}_L := (2.5 + 0.8\cdot j)\cdot\Omega$ and the secondary voltage is $V_2 := 36\cdot V$

$R_m := 2\cdot k\Omega$ $R_s := 2\cdot\Omega$ $X_m := 800\cdot\Omega$ $X_s := 5\cdot\Omega$ $N := 5$

a) Draw the model with the load connected. Label parts, voltages and currents as needed for the rest of the problem.

b) Find the primary, source voltage. Magnitude only. $|\mathbf{V}_S|$ = ?

c) Find the total complex power supplied the primary, source voltage. $\mathbf{S}_S = P_S + j\cdot Q_S$ = ?

d) Find the magnitude of the current flowing from the primary, source voltage. $|\mathbf{I}_S|$ = ?

f) The transformer would be fully loaded if $V_S := 208 \cdot V$ and $Z_L := 2 \cdot \Omega$ all real
Find the voltage regulation as defined in your notes. %VR = ?

2. The parameters of a step-down transformer are shown below. The primary voltage is $V_S := 120 \cdot V$
The transformer is loaded with $\mathbf{Z_L} = R_L + jX_L$ and the secondary current is $I_2 := 3.2 \cdot A$

$R_m := 1.5 \cdot k\Omega$ $R_s := 5 \cdot \Omega$ $X_m := 1 \cdot k\Omega$ $X_s := 7 \cdot \Omega$ $N := 4$

a) The primary, source voltage provides 40 VARs $Q_S := 40 \cdot VAR$ Find X_L
Hint: draw the model with the load.

b) Find R_L

c) Find the efficiency of this transformer.

Non-Ideal transformers, tests

3. A 500V/200V, 30-kVA, 60-Hz transformer is subjected to a SC test. The secondary is short-circuited and the primary voltage is raised until rated current is flowing. This occurs when the applied voltage equals 8.2% of rated winding voltage. The transformer consumes 600 W during the test. $P_{SC} := 600 \cdot W$

   a) Compute the series impedance $\mathbf{Z_s} = R_s + jX_s$ of the transformer.

   b) Compute the core flux during the SC test. (Express its magnitude in percent of normal operating flux.)

   c) Why is it permissible to assume that all of the 600 W constitute ohmic losses in R, and no part of it is core loss?

4. The same 30-kVA transformer is subjected to an OC test. The transformer consumes 500 W and draws 1.8 A.

   a) Find R_m and X_m.

   b) The open-circuit voltage measured on the secondary is 206V. Find the actual turns ratio.

5. Same transformer, but now the following impedance is hooked to the secondary: $\mathbf{Z}_L := (1.3 + 0.2\cdot j)\cdot\Omega$

a) Find the currents in both windings and the secondary voltage by use of the ideal (IT) model. $V_P := 500\cdot V$

b) Same as in part a) but now include the transformer impedances and actual turns ratio in your analysis. Take note of the change in your answers.

Differences between the ideal and non-ideal are only minor due to the additional windings on the secondary.

c) Find the efficiency.

d) Is the transformer current-overloaded?

6. A transformer is rated at $210\text{V} / 70\text{V}, 420\text{VA}$.
   The following values were found by making the standard OC and SC tests. R_m and X_m were neglected when finding the other two components.

$R_m := 2 \cdot k\Omega$ $X_m := 747 \cdot \Omega$

$R_s := 4 \cdot \Omega$ $X_s := 8.2 \cdot \Omega$ $N := 2.85$

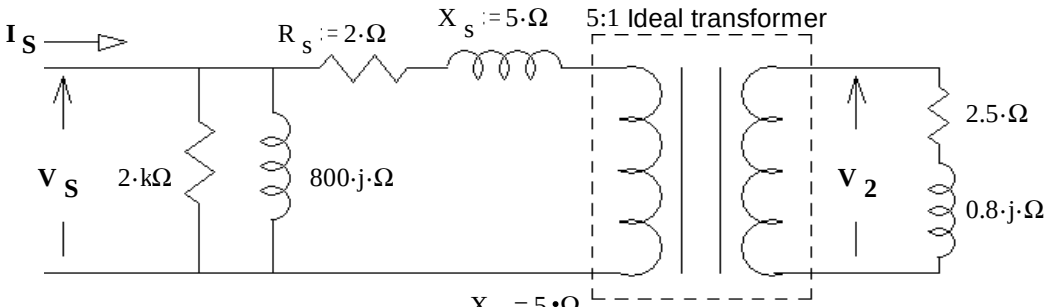
   a) Draw the standard non-ideal transformer model and label the parts.

   b) What were the measurements that were taken in the standard open-circuit test? (Give me numbers)

   c) What were the measurements that were taken in the standard short-circuit test? (Give me numbers)

Answers

1. a)



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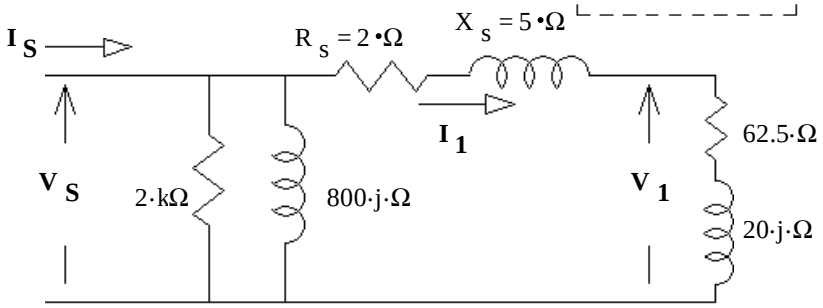


b) 189.7·V c) $503.3 + 233.1 \cdot j$ VA d) 2.923·A e) 93.4·% f) 4.48·%

2. a) 2.062·Ω b) 8.723·Ω c) 87.5·%

3. a) $0.167 + 0.663j \cdot \Omega$ b) 8.2% of normal rated value.

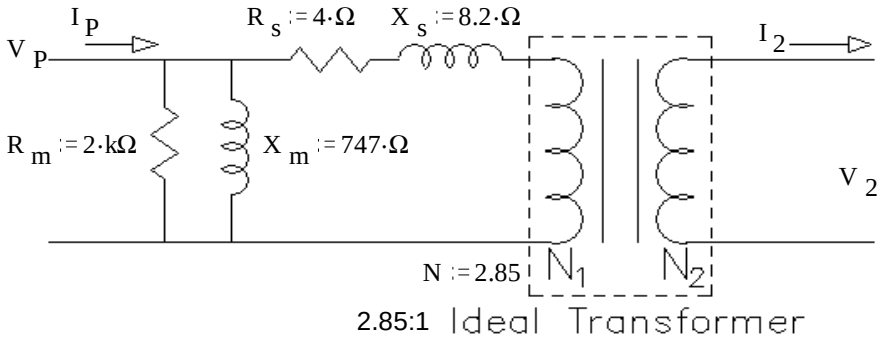
   c) Because the core flux is 8.2% of normal rated value, the core losses (which are approximately proportional to the square of the flux) are negligible.

4. a) 500·Ω & 334·Ω b) 2.427

5. a) 60.8·A 152.1·A 200·V b) 62.2·A a little more 151·A a little less 198.6·V

   c) 96.3·% d) yes, barely.

6. a)



b) 22.05·W 0.3A 73.68·V

c) 16·W 18.25·V