LAB 4 DATA

Data is provided here for the transformer in Lab 4 that you may use for your report. The plots on pages 2-3 show traces that would be observed on the oscilloscope. Phases are stated with respect to \( v_T(t) \), the voltage at the terminals of the waveform generator. The phasor voltages are peak values (not rms).

1. Source at primary with “helper” resistor \( R_h = 10 \Omega \), open-circuit secondary:
   \[
   \begin{align*}
   v_T & = 0.54 \angle 0^\circ \text{ V} \\
   v_1 & = 0.40 \angle 36.6^\circ \text{ V} \\
   v_2 & = 3.63 \angle 41.2^\circ \text{ V}
   \end{align*}
   \]

2. Source at secondary with “helper” resistor \( R_h = 1 \text{k}\Omega \), open-circuit primary:
   \[
   \begin{align*}
   v_T & = 19.61 \angle 0^\circ \text{ V} \\
   v_1 & = 1.33 \angle 41.2^\circ \text{ V} \\
   v_2 & = 14.80 \angle 36.6^\circ \text{ V}
   \end{align*}
   \]
   (When you calculate \( M \), you can average the estimates obtained in parts 1 and 2. Ideally both would give the same result, but they are different due to measurement errors.)

3. Source at primary with “helper” resistor \( R_h = 10 \Omega \), load resistor \( R_L = 5 \text{k}\Omega \) at secondary:
   \[
   \begin{align*}
   v_T & = 0.56 \angle 0^\circ \text{ V} \\
   v_1 & = 0.39 \angle 32.4^\circ \text{ V} \\
   v_2 & = 3.34 \angle 34.3^\circ \text{ V}
   \end{align*}
   \]
   Calculate the currents \( I_1 \) and \( I_2 \) from the voltage phasors, and compare the phasor voltages and currents with the ideal transformer equations using \( n = \sqrt{L_2/L_1} \).
   How closely do the voltages and currents match the ideal transformer model?
   Replace the transformer and load with a single “reflected impedance” \( Z_R \) calculated using the linear and ideal transformer models (you will get a different \( Z_R \) for each model).
   Which \( Z_R \) gives a closer approximation to the given \( v_1 \) and \( I_1 \) phasor values?
   Also calculate the average power delivered to the load resistor (using \( v_2 \)).
   When the same load is attached at nodes \( a-b \) with the same helper resistor:
   \[
   v_L = v_{a-b} = 1.98 \angle 0^\circ \text{ V}
   \]
   Use this to calculate the average power delivered to load if the transformer is removed.

See plots of voltage waveforms on pages 2 and 3 (available online, but not included on handout given in class).
SOURCE AT PRIMARY, OPEN CIRCUIT SECONDARY, $R_h = 10 \Omega$

SOURCE AT SECONDARY, OPEN CIRCUIT PRIMARY, $R_h = 1 \, k\Omega$
SOURCE AT PRIMARY, 5 kΩ LOAD AT SECONDARY, $R_h = 10 \, \Omega$

- $v_T(t)$
- $v_1(t)$
- $v_2(t)$

TIME (sec)

VOLTS