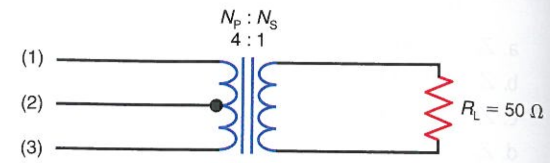
19–50 In Fig. 19-45, calculate the impedance Z_P across primary leads: (a) 1 and 3; (b) 1 and 2. (Note: Terminal 2 is a center-tap connection on the transformer primary. Also, the turns ratio of 4:1 is specified using leads 1 and 3 of the primary.)

19–51 Refer to Fig. 19-36. If the transformer has an efficiency of 80 percent, calculate the primary current I_P.

Figure 19-45 Circuit for Critical Thinking Prob. 19-50.



Answers to Self-Reviews

19–1 a. coil with an iron core
b. time B

19–2 a. 2 H
b. 32 mH

19–3 a. 2 V
b. 200 V

19–4 a. true
b. true

19–5 a. 1
b. 18 mH

19–6 a. 240 V
b. 0.1 A
c. false
d. increase

19–7 a. true
b. true
c. false

19–8 a. false
b. false
c. true

19–9 a. iron core
b. 60 MHz

19–10 a. true
b. true
c. true

19–11 a. true
b. true

19–12 a. 1.5 mH
b. 0.33 mH

19–13 a. joule
b. more

19–14 a. true
b. true
c. true

19–15 a. infinite ohms
b. 120 V
c. series

Laboratory Application Assignment

In this lab application assignment you will examine how a transformer can be used to step up or step down an ac voltage. You will measure the primary and secondary voltages as well as the primary and secondary currents for different values of load resistance connected to the secondary. From the measured values of voltage and current you will determine the primary and secondary power as well as the percent efficiency.

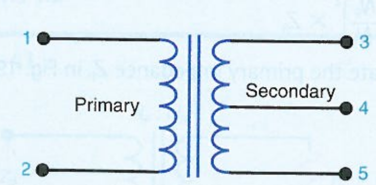
Equipment: Obtain the following items from your instructor.

- Isolation transformer and Variac
- Transformer: 120-V primary, 25.2-V, 2-A secondary with center tap
- 25-Ω, 50-Ω, and 100-Ω power resistors (50-W power rating)
- SPST switch
- 2 DMMs

Resistance Measurements

Examine the transformer supplied to you for this experiment. By inspection, determine the primary and secondary leads of the transformer and relate it to the schematic symbol shown in Fig. 19-46.

Figure 19-46



With a DMM, measure and record the resistance across each of the following transformer terminals. (Set the DMM to the lowest resistance range.)

$R_{1\text{-}2}$ = _____, $R_{3\text{-}4}$ = _____, $R_{4\text{-}5}$ = _____, $R_{3\text{-}5}$ = _____,
$R_{1\text{-}3}$ = _____, $R_{2\text{-}5}$ = _____, $R_{1\text{-}4}$ = _____, $R_{2\text{-}4}$ = _____

Which resistance measurements indicate isolation between the transformer windings? _____

Effect of DC Voltage and Current

Connect a 10-Vdc supply to primary terminals 1 and 2 in Fig. 19-46. Next, measure and record the following dc voltages in the secondary:

$V_{3\text{-}4}$ = _____, $V_{4\text{-}5}$ = _____, $V_{3\text{-}5}$ = _____

Are these measured voltages what you expected? If so, why? _____

Transformer Circuit

Caution: In this part of the lab you will be working with 120 Vac. For your safety, you will need to use an isolation transformer. Plug the isolation transformer into the 120-Vac outlet on your benchtop and in turn plug the Variac into the isolation transformer. Next adjust the Variac for an output of 120 Vac. This is the voltage you will apply directly to the transformer primary.

Unloaded Secondary

Connect the circuit in Fig. 19-47. (Be sure the DMM in the primary is set to measure ac current.) Switch S_1 is open. With exactly 120 Vac applied to the primary, measure and record the following secondary voltages:

$V_{3\text{-}4}$ = _____, $V_{4\text{-}5}$ = _____, $V_{3\text{-}5}$ = _____

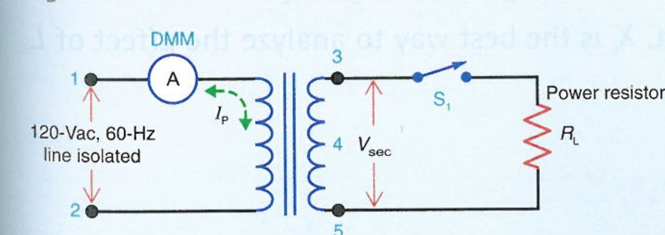
Based on your measured values, calculate the transformer turns ratio from the primary (1 and 2) to secondary (3 and 5). (Recall that $N_P/N_S = V_P/V_S$.)

$V_{1\text{-}2}/V_{3\text{-}5}$ = _____/_____

Does the full secondary voltage, $V_{3\text{-}5}$, measure higher than its rated value? _____

Why? _____

Figure 19-47



Record the primary current, I_P, indicated by the DMM.
I_P = _____

R_L = 100 Ω

Close S_1. Measure and record the following values:

V_S = _____, I_P = _____

Make the following calculations based on the measured values of V_S and I_P.

Calculate I_S as V_S/R_L. I_S = _____

Calculate P_S as $V_S \times I_S$. P_S = _____

Calculate P_P as $V_P \times I_P$. P_P = _____

Calculate the % efficiency as $P_S/P_P \times 100$.
% efficiency = _____

Repeat this procedure for each of the remaining load resistance values.

R_L = 50 Ω

Close S_1. Measure and record the following values:

V_S = _____, I_P = _____

Make the following calculations based on the measured values of V_S and I_P.

Calculate I_S as V_S/R_L. I_S = _____

Calculate P_S as $V_S \times I_S$. P_S = _____

Calculate P_P as $V_P \times I_P$. P_P = _____

Calculate the % efficiency as $P_S/P_P \times 100$.
% efficiency = _____

R_L = 25 Ω

Close S_1. Measure and record the following values:

V_S = _____, I_P = _____

Make the following calculations based on the measured values of V_S and I_P.

Calculate I_S as V_S/R_L. I_S = _____

Calculate P_S as $V_S \times I_S$. P_S = _____

Calculate P_P as $V_P \times I_P$. P_P = _____

Calculate the % efficiency as $P_S/P_P \times 100$.
% efficiency = _____

As the load resistance decreased in value, what happened to each of the following quantities?

I_S? _____, I_P? _____, P_S? _____, P_P? _____ % efficiency? _____