Tut-03

2–2. A 20-kVA 8000/480-V distribution transformer has the following resistances and reactances:

$$R_P = 32\ \Omega \qquad R_S = 0.05\ \Omega$$
$$X_P = 45\ \Omega \qquad R_S = 0.06\ \Omega$$
$$R_C = 250\ \text{k}\Omega \qquad X_M = 30\ \text{k}\Omega$$

The excitation branch impedances are given referred to the high-voltage side of the transformer.

(a) Find the equivalent circuit of this transformer referred to the high-voltage side.
(b) Find the per-unit equivalent circuit of this transformer.
(c) Assume that this transformer is supplying rated load at 480 V and 0.8 PF lagging. What is this transformer's input voltage? What is its voltage regulation?
(d) What is the transformer's efficiency under the conditions of part (c)?

2–3. A 1000-VA 230/115-V transformer has been tested to determine its equivalent circuit. The results of the tests are shown below.

Open-circuit test	Short-circuit test
$V_{OC} = 230$ V	$V_{SC} = 19.1$ V
$I_{OC} = 0.45$ A	$I_{SC} = 8.7$ A
$P_{OC} = 30$ W	$P_{SC} = 42.3$ W

All data given were taken from the primary side of the transformer.

(a) Find the equivalent circuit of this transformer referred to the low-voltage side of the transformer.
(b) Find the transformer's voltage regulation at rated conditions and (1) 0.8 PF lagging, (2) 1.0 PF, (3) 0.8 PF leading.
(c) Determine the transformer's efficiency at rated conditions and 0.8 PF lagging.

2–4. A single-phase power system is shown in Figure P2–1. The power source feeds a 100-kVA 14/2.4-kV transformer through a feeder impedance of $40.0 + j150\ \Omega$. The transformer's equivalent series impedance referred to its low-voltage side is $0.12 + j0.5\ \Omega$. The load on the transformer is 90 kW at 0.80 PF lagging and 2300 V.
(a) What is the voltage at the power source of the system?
(b) What is the voltage regulation of the transformer?
(c) How efficient is the overall power system?

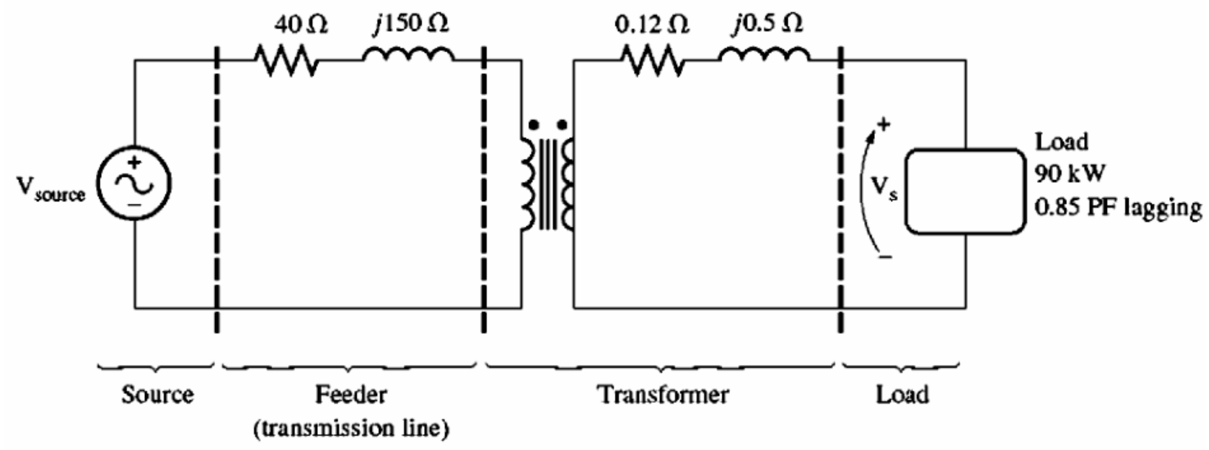

FIGURE P2–1
The circuit of Problem 2–4.

2–5. When travelers from the United States and Canada visit Europe, they encounter a different power distribution system. Wall voltages in North America are 120 V rms at 60 Hz, while typical wall voltages in Europe are 220 to 240 V at 50 Hz. Many travelers carry small step-up/step-down transformers so that they can use their appliances in the countries that they are visiting. A typical transformer might be rated at 1 kVA and 120/240 V. It has 500 turns of wire on the 120-V side and 1000 turns of wire on the 240-V side. The magnetization curve for this transformer is shown in Figure P2–2, and can be found in file `p22.mag` at this book's website.
(a) Suppose that this transformer is connected to a 120-V, 60-Hz power source with no load connected to the 240-V side. Sketch the magnetization current that would flow in the transformer. (Use MATLAB to plot the current accurately, if it is available.) What is the rms amplitude of the magnetization current? What percentage of full-load current is the magnetization current?
(b) Now suppose that this transformer is connected to a 240-V, 50-Hz power source with no load connected to the 120-V side. Sketch the magnetization current that would flow in the transformer. (Use MATLAB to plot the current accurately, if it is available.) What is the rms amplitude of the magnetization current? What percentage of full-load current is the magnetization current?
(c) In which case is the magnetization current a higher percentage of full-load current? Why?

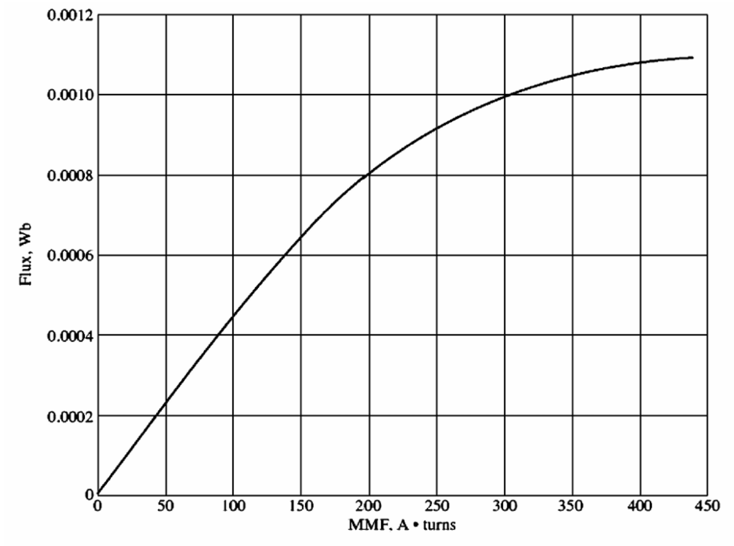

FIGURE P2–2
Magnetization curve for the transformer of Problem 2–5.

2–6. A 15-kVA 8000/230-V distribution transformer has an impedance referred to the primary of $80 + j300\ \Omega$. The components of the excitation branch referred to the primary side are $R_C = 350\ \text{k}\Omega$ and $X_M = 70\ \text{k}\Omega$.
(a) If the primary voltage is 7967 V and the load impedance is $Z_L = 3.0 + j1.5\ \Omega$, what is the secondary voltage of the transformer? What is the voltage regulation of the transformer?
(b) If the load is disconnected and a capacitor of $-j4.0\ \Omega$ is connected in its place, what is the secondary voltage of the transformer? What is its voltage regulation under these conditions?