In the name of Almighty

EE Course 25741
Energy Conversion 1

Assignment 2 – Single phase transformers

Due date: 1393/12/16

1. Can a 60Hz transformer be operated on a 50 Hz system? What actions are required to enable this operation?

2. A 30-kVA 7000/250-V distribution transformer has the following resistances and reactances:

$R_P = 25\,\Omega$ $R_S = 0.03\,\Omega$

$X_P = 35\Omega$ $X_S = 0.03\,\Omega$

$R_C = 230\,\text{k}\Omega$ $X_M = 25\,\text{k}\Omega$

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 250 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)?

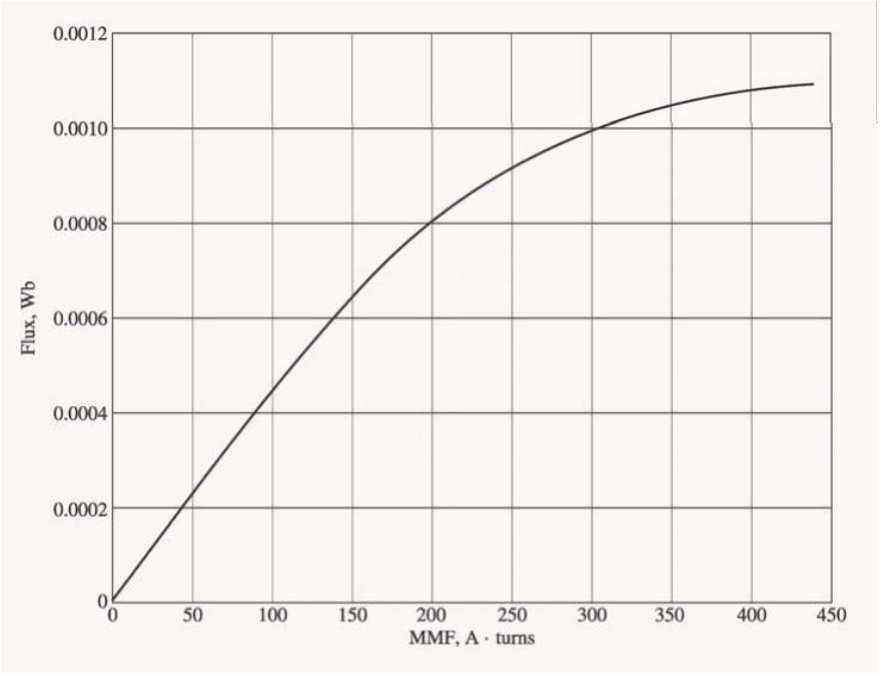
3. A 1000-VA 230/115-V transformer has been tested to determine its equivalent circuit. The results of the tests are shown below.

Open-circuit test	Short-circuit test
V_{OC} 240 V	V_{SC} = 20.1 V
I_{OC} = .55 A	I_{SC} = 9.8 A
P_{OC} = 33 W	P_{SC} = 40.3 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.

4. When travelers from the USA 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.dat` at this book's Web site.



(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?

5. A 5000-kVA 230/13.8-kV single-phase power transformer has a per-unit resistance of 1 percent and a per-unit reactance of 5 percent (data taken from the transformer's nameplate). The open-circuit test performed on the low-voltage side of the transformer yielded the following data:

V_{OC} = 14.8 kV $\quad$ I_{OC} = 14.1A $\quad$ P_{OC} = 50.1 kW

(a) Find the equivalent circuit referred to the low-voltage side of this transformer.
(b) If the voltage on the secondary side is 13.8 kV and the power supplied is 4000 kW at 0.8 PF Lagging, find the voltage regulation of the transformer. Find its efficiency.

6. A 250-MVA 20/300-kV single-phase power transformer has a per-unit resistance of 1.2 percent and a per- unit reactance of 5 percent (data taken from the transformer's nameplate). The magnetizing impedance is *j*80 per unit.

(a) Find the equivalent circuit referred to the low-voltage side of this transformer.
(b) Calculate the voltage regulation of this transformer for a full-load current at power factor of 0.8 lagging.
(c) Assume that the primary voltage of this transformer is a constant 15 kV, and plot the secondary voltage as a function of load current for currents from no-load to full-load. Repeat this process for power factors of 0.8 lagging, 1.0, and 0.8 leading.