King Fahd University of Petroleum & Minerals
Electrical Engineering Department
Semester-162
EE 306: Electromechanical Devices

Homework-III
(Single-Phase Transformers)

Problem 1:

A 25-kVA, 2400/240 V, 60 Hz single-phase distribution transformer has been tested for open and short circuit tests as shown in the table below.

Test	Voltage (V)	Current (A)	Power (W)
Open-Circuit (HV Open)	240	3.2	165
Short-Circuit (LV shorted)	55	10.4	375

(a) Draw the approximate equivalent circuit of this transformer referred to the high-voltage side showing all given and calculated variables.

(b) When the transformer is delivering full rated KVA at 0.85 power factor lagging determine the voltage regulation and transformer efficiency.

(c) Determine the maximum efficiency

Problem-2:

A single-phase power distribution system is shown in Figure 1. The power source feeds a 100-kVA, 14/2.4-kV transformer through a feeder impedance of $38.2 + j\,140\ \Omega$. The transformer's equivalent series impedance referred to its low-voltage side is $0.10 + j0.40\ \Omega$. The load on the transformer is 90 kW at 0.8 PF lagging and 2400 V.
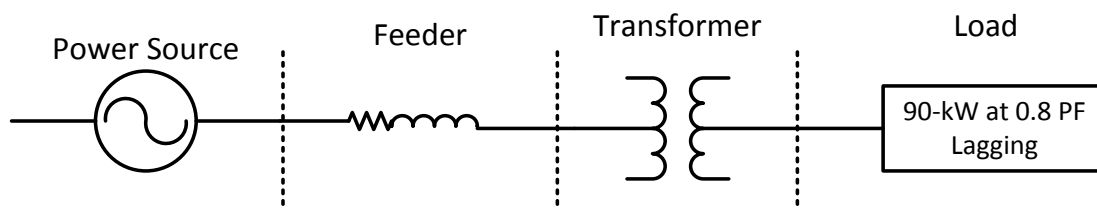

Figure 1: Single-Phase Distribution System

(a) Deduce and draw single phase equivalent circuit for the power system.

(b) What is the voltage at the power source of the system?

(c) What is the voltage regulation of the transformer?

(d) How efficient is the overall power system?

Problem-3:

A 30-kVA, 8000/230-V distribution transformer has equivalent series impedance referred to the primary of $20 + j100\ \Omega$. The components of the excitation branch referred to the primary side are $R_C = 100\ k\Omega$ and $X_m = 20\ k\Omega$.

(a) If the primary voltage is 7967 V and the load impedance is $Z_L = 2.0 + j0.7\ \Omega$, 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 $-j3.0\ \Omega$ is connected in its place, what is the secondary voltage of the transformer? What is the voltage regulation under these conditions?

Problem-4:

The resistance and leakage reactance of a 10-KVA, 50-Hz, 2200/220- V distribution transformer are as follows:

$$R_1 = 4\ \Omega\quad R_2 = 0.04\ \Omega\quad X_1 = 5.0\ \Omega\quad X_2 = 0.05\ \Omega$$

(a) Find the total equivalent series impedance referred to, (i) HV side (ii) LV side

(b) Consider the transformer to deliver its rated KV A at 0.8 PF lagging to a load at rated voltage. Find the HV terminal voltage and percent voltage regulation.

(c) Repeat part (b) for a PF of 0.8 leading.

(d) Consider the core loss to be 80 W. Find the efficiency under the conditions of part (b). Will it be different for the conditions under part (c)?