Information Technology University, Lahore

Electrical Machines

BSEE-19 Fall 2021

Assignment No. 2

Issue Date: Thursday Oct. 21, 2021 **Total Marks: 100**

Due Date: Friday Oct. 29, 2021 (Upload on Google classroom before 5:00 pm)

Course Instructor: Hadia Sajjad

Carefully Read Instructions

1. Please review the University Plagiarism Policy. Please submit your own work only.
2. Late submission will not be accepted.
3. Assignment should be uploaded as pdf file.
4. The name of file should be your Roll Number as BSEEXXXX.
5. Handwriting must be very neat and legible. You may lose points otherwise.
6. Please show all steps for full credit.

Question 1: (15 marks)

a) A 50-kVA 2400:240-V 60-Hz distribution transformer has a leakage impedance of 0.72 + j0.92 Ω in the high-voltage winding and 0.0070 + j0.0090 Ω in the low-voltage winding. At rated voltage and frequency, the impedance Z_φ of the shunt branch (equal to the impedance of R_c and jX_m in parallel) accounting for the exciting current is 6.32 + j43.7 Ω when viewed from the low-voltage side. Draw the equivalent circuit referred to
   i. the high-voltage side
   ii. the low-voltage side, and label the impedances numerically.

b) If 2400 V rms is applied to the high-voltage side of the transformer in above problem, calculate the magnitude of the current into the magnetizing impedance Z_φ for both (i) and (ii) parts.

Question 2: (15 marks)

a) With the instruments located on the high-voltage side and the low-voltage side short-circuited, the short-circuit test readings for the 50-kVA 2400:240-V transformer of Problem 1 are 48 V, 20.8 A, and 617 W. An open-circuit test with the low-voltage side

energized gives instrument readings on that side of 240 V, 5.41 A, and 186 W. Determine the efficiency and the voltage regulation at full load, 0.80 power factor lagging.

b) Repeat the voltage-regulation calculation of problem 2 part (a) for a load of 50 kW rated load, unity power factor.

Question 3: (15 marks)

The 2400:240-V 50-kVA transformer of problem 2 is connected as an autotransformer, as shown in Fig.1.1, in which ab is the 240-V winding and bc is the 2400-V winding. (It is assumed that the 240-V winding has enough insulation to withstand a voltage of 2640 V to ground.)

a) Compute the voltage ratings V_H. and V_L of the high- and low-voltage sides, respectively, for this autotransformer connection.
b) Compute the kVA rating as an autotransformer.
c) Data with respect to the losses are given in problem 2. Compute the full-load efficiency as an autotransformer operating with a rated load of 0.80 power factor lagging.

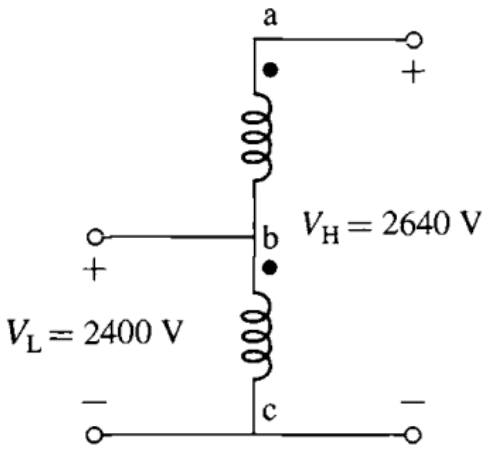

Figure 1.1 Auto-Transformer

Question 4: (15 marks)

The exciting current measured on the low-voltage side of a 50-kVA, 2400:240-V transformer is 5.41 A. Its equivalent impedance referred to the high-voltage side is 1.42 + j 1.82 Ω. Using the transformer rating as the base, express in per unit on the low- and high-voltage sides

a) The exciting current.
b) The equivalent impedance.

Question 5: (20 marks)

The readings of the open circuit (OC) and the short circuit (SC) test on a single phase 10kVA, 450:120V, 60Hz transformer are:

OC test on the secondary side primary opened. SC test on the Primary with the secondary side short circuited.

V_{OC} = 120 V	V_{SC} = 9.65 V
I_{OC} = 4.2 A	I_{SC} = 22.2 A
P_{OC} = 80 W	P_{SC} = 120 W

Determine the following:

a) The approximate equivalent circuit.
b) The efficiency and voltage regulation when supplying full load at the 0.8 pf lagging.
c) The efficiency when supplying half full-load at the 0.8 pf lagging.

Question 6: (20 marks)

A 150-MVA, 15/200-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) Calculate the copper and core losses in the transformer at the conditions in (b).
d) 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.

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