ECE 385 – Fall 2024

Instructor: Michael Abba
TA: Bishal Lamichhane

HW #3

Due Date: Uploaded to D2L by 10 PM Friday October 4, 2024

Problem 1

A 1φ, 25 kVA, 2300/230 V transformer has the following parameters:

$Z_{eq,H} = 4.0 + j5.0\ \Omega$
$R_{c,L} = 450\ \Omega$
$X_{m,L} = 300\ \Omega$

a. Determine efficiency when the transformer delivers full load at rated voltage and 0.85 power factor lagging.
b. Determine the percentage loading of the transformer at which the efficiency is a maximum and calculate this efficiency if the power factor is 0.85 and load voltage is 230 V.

Problem 2

A 1φ, 10 kVA, 460/120 V, 60 Hz transformer has an efficiency of 96% when it delivers 9 kW at 0.9 power factor. This transformer is connected as an autotransformer to supply load to a 460 V circuit from a 580 V source.

a. Show the autotransformer connection.
b. Determine the maximum kVA the autotransformer can supply to the 460 V circuit.
c. Determine the efficiency of the autotransformer for full load at 0.9 power factor.

Problem 3

A 1φ, 200 kVA, 2100/210 V, 60 Hz transformer has the following characteristics. The impedance of the high-voltage winding is 0.25+j1.5Ω with the low-voltage winding short-circuited. The admittance (i.e., inverse of impedance) of the low-voltage winding is 0.025−j0.075 mhos with the high-voltage winding open-circuited.

a. Taking the transformer rating as base, determine the base values of power, voltage, current, and impedance for both the high-voltage and low-voltage sides of the transformer.
b. Determine the per-unit value of the equivalent resistance and leakage reactance of the transformer.
c. Determine the per-unit value of the excitation current at rated voltage.
d. Determine the per-unit value of the total power loss in the transformer at full-load output condition.

Problem 4

The λ−i relationship for an electromagnetic system is given by

$$\lambda = \frac{1.2i^{1/2}}{g}$$

where g is the air gap length. For current i = 2 A and g = 10 cm, determine the mechanical force on the moving part

a. Using the energy of the system.
b. Using the coenergy of the system

Problem 5

An electromagnet lift system is shown in the figure below. The coil has 2500 turns. The flux density in the air gap is 1.25 T. Assume that the core material is ideal.

a. For an air gap, g=10mm:
    i. Determine the coil current.
    ii. Determine the energy stored in the magnetic system.
    iii. Determine the force on the load (sheet of steel).
    iv. Determine the mass of the load (acceleration due to gravity = 9.81 m/sec^2).
b. If the air gap is 2 mm, determine the coil current required to lift the load.