Tutorial 2 (Unit – 2: Magnetic Circuits and Transformers)

Principles of Electrical Engineering (EEEA1110)

Series and Parallel Magnetic circuits:

Q. 1: In the magnetic circuit detailed in figure 1 with all dimensions in mm, calculate the required current to be passed in the coil having 200 turns in order to establish a flux of 1.28 mWb in the air gap. Permeability of air may be taken as, $\mu 0 = 4\pi \times 10^{-7}$ H/m. The B-H curve of the material is given here in figure 2.

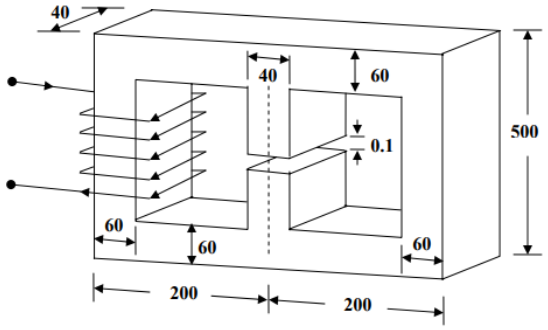

Fig. 1 The magnetic circuit with dimensions.

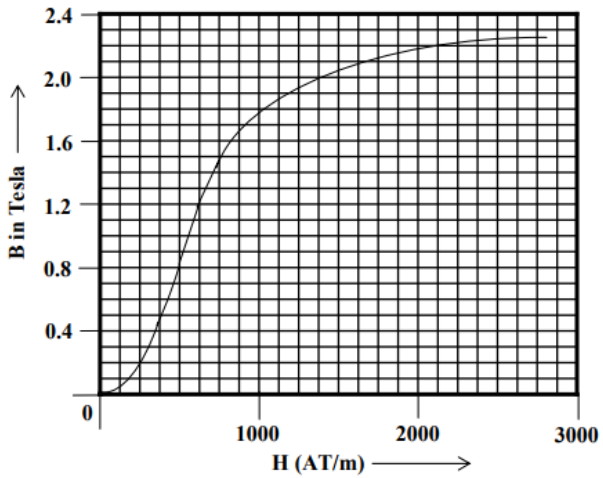

Fig. 2 The B-H curve of the material.

[Ans: 3.61 A]

Ideal Transformer:

Q. 2: Consider an ideal transformer with N_1 = 100 and N_2 = 500. The primary is connected to a 100 V source. A load of 100 Ω is connected to the secondary. Find the power delivered to the load.

[Ans: 2500 Watt]

Q. 3: An ideal transformer has a turn ratio of 100/300. The LV winding is connected to a source of 3.3 kV, 50 Hz. An impedance of (100 + j35) Ω is connected across the secondary terminals. Calculate:
(a) The value of maximum core flux.
(b) The primary and secondary currents.
[Ans: (a) 0.149 Wb
(b) primary current: $280.3 < -19.3^o$ A and secondary current: $93.44 < -19.3^o$ A]

Equivalent Circuit using referred values:

Q. 4: A 50 kVA, 1100/220 V has primary and secondary resistance and leakage reactance as below:

	Resistance	Leakage reactance
Primary (HV)	0.125 Ω	0.625 Ω
Secondary (LV)	0.005 Ω	0.25 Ω

Calculate the impedance of the transformer referred to HV and LV.

[Ans: Referred to HV side= 0.25 + j 1.25 Ω and referred to LV side = 0.01 + j0.05 Ω]

Q. 5: A single- phase, 600 kVA, 2400/600 V transformer has the following circuit model parameters:

$r_1 = 0.05\ \Omega$ $r_2 = 0.004\ \Omega$
$x_1 = 0.025\ \Omega$ $x_2 = 0.016\ \Omega$
$R_1 = 1667\ \Omega$ $X_m = 417\ \Omega$ (as seen on HV side)

Draw its equivalent circuit as seen from LV side.

Efficiency of the transformer:

Q. 6: Prove that for a given power factor, the efficiency of a transformer will be maximum when the variable copper loss is equal to the constant iron (core) loss.

Q. 7: In a transformer if the load current is kept constant, find the power factor at which the maximum efficiency occurs.

Q. 8: A single phase transformer working at unity power factor has an efficiency of 90% at both half load and at the full-load of 500 W. Determine the efficiency at 75% full load and the maximum efficiency.

[Ans: 0.9051 pu = 90.51 %]

Voltage Regulation:

Q. 9: The resistance and leakage reactances of a 10 kVA, 50 Hz, 2300/230 V distribution transformer are:

$r_1 = 3.96\ \Omega$ $r_2 = 0.0396\Omega$
$x_1 = 15.8\ \Omega$ $x_2 = 0.158\ \Omega$

Subscript 1 refers to HV and 2 to LV winding. The transformer delivers rated kVA at 0.8 pf lagging to a load on the LV side. Find

(a) The HV- side voltage necessary to maintain 230 V across load terminals.
(b) The percentage voltage regulation

[Ans: (a) 2410 V (b) 4.78 %]

Q. 10: A 10 kVA, 2000/400 V, single phase transformer at no load has

$r_1 = 5.5\ \Omega$ $r_2 = 0.2\ \Omega$
$x_1 = 12\ \Omega$ $x_2 = 0.45\ \Omega$

at full load, 0.8 power factor (lagging) and the primary applied voltage of 2000 V,

determine:

(a) The approximate value of the secondary voltage

(b) Voltage regulation

[Ans: (a) 377.65 V (b) 5.92 %]