Transformer Project: Task 1

EEE2044S – Power Engineering

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AIM:

The aim of this task is to design a transformer by means of analytical design equations.

CALCULATIONS:

1) Use the VA rating and voltage ratio to determine the rated primary and secondary currents

Power rating: 3VA
Primary Voltage: 30V
Secondary Voltage: 12V

- **Primary Current:**
  P = IV
  $I = \frac{P}{V} = \frac{3VA}{30V}$
  $I_{primary} = 0.1A$

- **Secondary Current:**
  P = IV
  $I = \frac{P}{V} = \frac{3VA}{12V}$
  $I_{secondary} = 0.25A$

2) Use the magnetization curves provided in the appendix to choose a suitable magnetic operation point for the transformer core. Justify your choice

We have chosen the point (100, 0.65); H=100At/m and B=0.65T
This point was chosen because it is in the linear region of the B-H curve and therefore hasn't saturated at this point.

3) Choose a suitable value for N_1 and solve for A. N_1 should not exceed 500 turns and number of laminations also should not exceed 80 laminations. (Hint: Use $V_1 = 4.44fN_1B_{max}A$)

Chose $N_1 = 209$ turns

$V_1 = 4.44fN_1B_{max}A$
$A = V_1 / 4.44f\ N_1B_{max}$

$A = 30 / (4.44)(50)(209)(0.65)$
⇨ $A = (0.9947*10^{-3})\ m^2$

4) Assume a stacking factor K_s=0.98, calculate the physical cross-sectional area. K_s is the ratio of magnetic steel area available for flux and the physical cross sectional area of the laminations with their insulation coating.

$A_{physical} = (1.02)(0.9947*10^{-3})$
$\underline{A_{physical} = (1.014*10^{-3})\ m^2}$

5) Using the physical cross sectional area, calculate the core depth and the number of laminations required for your transformer, given that the thickness of one lamination is 0.5mm

Depth, $d = A / 25.4*10^{-3}$
$d = 1.014*10^{-3} / 25.4*10^{-3} = (39.95*10^{-3})$ m
$\underline{d = 40mm}$

1 layer = 0.5mm thick
? layer = 40 mm
⇨ $\underline{80\ laminations\ needed}$

6) Use the above information along with the number of turns and size of the transformer window to choose an appropriate size for each winding. Note that the allowable current density for a winding is approximately 3A/mm^2. (Hint: you can use the attached American Wire Gauge conversion table to determine the appropriate wire diameter)

Winding 1:

$I_1 = 0.1A$ and $I_{1max} = 0.141A$

Current Density = $I / A_w = 3A/mm^2$

$A_w = 0.141 / 3 = \underline{0.047\ mm^2}$

Thus, reading off the chart:
⇨ $\underline{Choose\ AWG\ N^o = 30}$

Winding 2:

$I_2 = 0.25A$ and $I_{2max} = 0.354A$

Current Density = $I / A_w = 3A/mm^2$

$A_w = 0.354 / 3 = \underline{0.118\ mm^2}$

Thus, reading off the chart:
⇨ $\underline{Choose\ AWG\ N^o = 26}$