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Subject Electrical Machine

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(1)

Q-1 A Square ferromagnetic Core has a mean path length of 55 cm & a cross Sectional area of 1500 cm^2. A 200 turn Coil of Wire is Wrapped around one leg of core. The Core is made of a material having magnetization Intensity (H) 115 A.turns/m

Find:

a) How much Current is required To Produce 0.012 Wb of flux in The Core?

b) What is The Core relative Permeability at That Current level? ($4\pi \times 10^{-7}$ H/m).

c) What is its relactance?

Sol:- (a) The required flux density in The Core is

$$B = \frac{\phi}{A} = \frac{1.012\,Wb}{0.015\,m^2} = 0.8T$$

The required magnetizing Intensity is

$$H = 115\,A.turns/m$$

The magnetomotive force needed To Produce This magnetizing Intensity is

$$\mathcal{F} = Ni = Hl_c$$

$$= (115\,A.turns/m)(0.55m) = 63.25\,A.turn$$

So the required current is

$$i = \frac{\mathcal{F}}{N} = \frac{63.25 \text{ A.turns}}{200 \text{ turns}} = \boxed{0.316 A}$$

(b) The core's permeability at this current is

$$\mu = \frac{B}{H} = \frac{0.8T}{115 \text{ A.turns/m}} = 0.00696 \text{ H/m}$$

Therefore the relative permeability is

$$\mu_r = \frac{\mu}{\mu_0} = \frac{0.00696 \text{ H/m}}{4\pi \times 10^{-7} \text{ H/m}} = \boxed{5540}$$

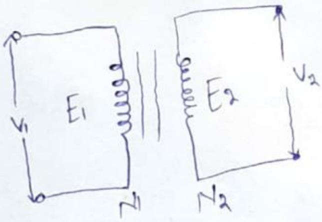
(c) The reluctance of the core is

$$\mathcal{R} = \frac{\mathcal{F}}{\phi} = \frac{63.25 \text{ A.turns}}{0.012 \text{ Wb}} = \boxed{5270 \text{ A.turns/Wb}}$$

(3)

Q-2 (a) Derive Voltage & Impedance relationship with turn ratio for an ideal transformer?

Ans:-



From the eq of Induced emf we have

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$$

The Constant K is Called Voltage transformation ratio. Thus if K = 5 (i.e $N_2/N_1 = 5$) Then $E_2 = 5E_1$.

For an Ideal Transformer:-

(1) $E_1 = V_1$ & $E_2 = V_2$ as there is no Voltage drop in the Windings.

$$\therefore \frac{E_2}{E_1} = \frac{V_2}{V_1} = \frac{N_2}{N_1} = K$$

(4)

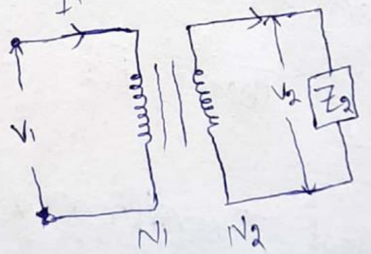
ii) There are no losses. therefore, Volt - amperes Input to the primary are equal to the output Volt - amperes i.e

$$V_1 I_1 = V_2 I_2$$

or $$\frac{I_2}{I_1} = \frac{V_1}{V_2} = \frac{1}{K}$$

Hence, Currents are in the inverse ratio of voltage transformation ratio. This simply means that if we raise the voltage, there is a corresponding decrease of current.

Impedance Ratio :-



Consider a transformer having Impedance Z_2 in the Secondary as shown in fig.

$$Z_2 = \frac{V_2}{I_2}$$

$$Z_1 = \frac{V_1}{I_1}$$

$$\therefore \frac{Z_2}{Z_1} = \left[\frac{V_2}{V_1}\right] \times \left[\frac{I_1}{I_2}\right]$$

or $$\frac{Z_2}{Z_1} = K^2$$

i.e Impedance ratio (Z_2/Z_1) is equal to the Square of Voltage transformation ratio.

In other words, an Impedance Z_2 in Secondary becomes Z_2/K^2 when transferred to Primary.

Likewise, an Impedance Z_1 in the Primary becomes $K^2 Z_1$ when transferred to the Secondary.

Similarly $\frac{R_2}{R_1} = K^2$ & $\frac{X_2}{X_1} = K^2$

We Can transfer the Parameter from one winding to the other. Thus

1) R_1 in the Primary become $K^2 R_1$ when transferred to the Secondary.
2) R_2 in the Secondary become R_2/K^2 when transferred to the Primary.
3) A reactance X_1 in the Primary becomes $K^2 X_1$ when transferred to the Secondary.
4) A reactance X_2 in the Secondary becomes X_2/K^2 when transferred to the Primary.

Q=3 (a) Define Power factor? Differentiate between Real, Apparent & reactive Powers?

Ans:- **Power factor:-** In electrical Engineering, the Power factor of an Ac electrical Power System is defined as the ratio of the real Power absorbed by the load to the apparent Power flowing in the circuit, & is a dimensionless number in the closed interval of -1 to 1. A Power factor of less than 1 indicates the voltage & current are not in phase, reducing the average power of the two. To calculate Power factor we need a Power Quality analyzer or Power analyzer that measures both working Power (KW) & apparent Power (KVA) & to calculate the ratio of KW/KVA

PF = (True Power)/(Apparent Power)

$$PF = W/VA$$