IQRA National University, Peshawar
Department of Electrical Engineering

Summers

Course Code: EEE342		**Course Title:**	Electrical Machines
Prerequisite: Circuit Analysis		**Instructor:**	Engr. Sanaullah Ahmad
Module:	**Program:** BEE	**Total Marks:** 30	**Time Allowed:**

Rafaqat ID 14107

Note: 1) Attempt all questions.
2) Calculators borrowing/exchange is prohibited.

(b) A square ferromagnetic core has a mean path length of 55cm and a cross-sectional area of 150cm^2. A 200 turn coil of wire is wrapped around one leg of the core. The core is made of a material having magnetization intensity (H) 115 A. turns/m. Find: Marks 10

a. How much current is required to produce 0.012 Wb of flux in the core?
b. What is the core's relative permeability at that current level? ($4\pi \times 10\text{-}7$H/m)
c. What is its reluctance?

CLO 2

Q2 (a) Derive Voltage and Impedance relationship with turn ratio for an ideal transformer? Marks 10

CLO 1

Q3 (a) Define power factor? Differentiate between Real, Apparent and reactive powers? Marks 10

CLO 1

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(4)

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Question # 01

Given Data:-

Core length = 55 cm = 0.55 m

Cross Area = 150 cm^2 = 0.01.5 m^2

intensity = H = 115 A-turns/m

Φ = 0.012 webers

N = 200 turns

Required:

I = ?

μ_r = ?

R = ?

First we will find Magnetic field = B

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Solution:

$$\Phi = B \cdot A$$

$$B = \frac{\Phi}{A}$$

$$= \frac{0.012}{0.015}$$

$$\boxed{B = 0.8 \text{ Tesla}}$$

$$B = \mu H$$

$$\mu = \frac{B}{H}$$

$$= \frac{0.8}{115}$$

$$\mu = 0.0069 \text{ H/m}$$

Now

$$\mu_r = \frac{0.0069}{3.14 \times 4 \times 10^{-7}} \qquad \because \mu_r = \frac{\mu}{\mu_0}$$

$$\mu_0 = 4\pi \times 10^{-7}$$

$$\boxed{\mu_r = 5540}$$

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③

$$T = HL$$

$$= 115 \times 0.55$$

$$\boxed{T = 63.25 \text{ A.turns}}$$

$$T = R\Phi$$

$$R = \frac{T}{\Phi}$$

$$= \frac{63.25}{0.012}$$

$$\boxed{R = 5270 \text{ A.turns/Wb}}$$

Now find Current

$$I = \frac{F}{N} \qquad \therefore T = F$$

$$= \frac{63.25}{200}$$

$$\boxed{I = 0.316 \text{ amps}}$$

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Question# 02

Answer: Voltage and Impedance Relationship:

Since

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$$

$$\alpha = \frac{N_P}{N_S}$$

where impedance = Z

$$Z = R + jX \qquad \because R = \text{Resistance}, \; jX = \text{Reactance}$$

$$V = IR$$

$$V = IZ \qquad R = Z$$

As

$$Z_P = \frac{V_P}{I_P}$$

and

$$Z_S = \frac{V_S}{I_S}$$

$$\alpha = \frac{N_P}{N_S} = \frac{V_P}{V_S}$$

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$$\alpha = \frac{V_P}{V_S}$$

$$\boxed{\alpha V_S = V_P} \quad \text{—— (1)}$$

$$\alpha = \frac{I_S}{I_P}$$

$$\frac{1}{\alpha} = \frac{I_P}{I_S}$$

$$\boxed{I_P = \frac{I_S}{\alpha}} \quad \text{—— (2)}$$

$$\boxed{Z_P = \frac{V_P}{I_P}} \quad \text{—— (A)}$$

Put eq (1) and (2) in (A)

$$Z_P = \frac{\alpha V_S}{I_S/\alpha}$$

$$= \alpha^2 \frac{V_S}{I_S}$$

$$Z_P = \alpha^2 \frac{V_S}{I_S}$$

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$$Z_p = \alpha^2 Z_s \qquad \because Z_s = \frac{V_s}{I_s}$$

$$\frac{Z_p}{Z_s} = \alpha^2$$

$$\frac{Z_p}{Z_s} = \left(\frac{N_p}{N_s}\right)^2 \qquad \because \alpha = \frac{N_p}{N_s}$$

Taking Square on B/S

$$\sqrt{\frac{Z_p}{Z_s}} = \sqrt{\left(\frac{N_p}{N_s}\right)^2}$$

$$\frac{N_p}{N_s} = \sqrt{\frac{Z_p}{Z_s}}$$

turn ratio for impedence in Ideal transformer.

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For Voltage:

EMF equation of Ideal Transformer

$$e_p = -N_p \frac{d\varphi}{dt}$$

$\therefore$ $V_m = V_m \sin\omega t$

$\varphi_m = \varphi_m \sin\omega t$

$$e_p = -N_p \frac{d}{dt}(\varphi_m \sin\omega t)$$

$$= -N_p \omega \cos\omega t \varphi_m + \sin\omega t$$

$$= -2\pi f N_p \cos\omega t \varphi_m + \sin\omega t$$

$$= -2\pi f N_p \sin(\omega t - 90^\circ) \varphi_m + \sin\omega t$$

$$= 2\pi f N_p \sin(90^\circ - \omega t) + \sin\omega t$$

$$e_p = 2\pi f N_p (1) + 0$$

max value

$$e_p = 2\pi f N_p \varphi_m$$

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(5)

$$\frac{V_{max}}{\sqrt{2}} = V_{rms}$$

$$e_{P_{rms}} = 4.44 f N_P \phi_m$$

$$e_{S_{rms}} = 4.44 f N_S \phi_m$$

$$\frac{e_{P\,rms}}{e_{S\,rms}} = \frac{4.44 f N_P \phi_m}{4.44 f N_S \phi_m}$$

$$\frac{e_P}{e_S} = \frac{N_P}{N_S}$$

Voltage Relationship of turn ratio for Ideal transformer.

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Question#03

Answer:

Power factor:

Power factor is the ratio between actual Power and apparent power.

Differenciation B|w Real, apparent and Reactive power:

1- Real Power:

Also know as "Active power". Real Power is the rate of Producing, transforing or using electrical energy it is measured in Watts. and often expressed in ~~Kilometer~~ Kilowatts. (KW).

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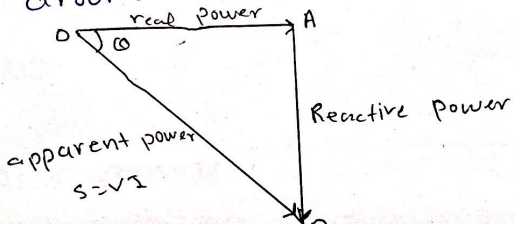
2- Apparent Power:

The product of the voltage in volts and current in amperas. It comprises both active and reactive power. It is measured in Volt-amperes and also expressed in kilowatt-amperes.

3- Reactive Power:

Reactive power is the power where the current is out of phase with the voltage and the "volts x amps" doesn't do any real work. Current that charges a capaitor, for example or current that creates the magnetic field around a coil for another.



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