1) The primary winding of a transformer is connected to a 240 V, 50 Hz supply. The secondary winding has 1500 turns. If the maximum value of the core flux is 0.00207 Wb, Determine 1) the secondary induced EMF 2) number of turns in the primary 3) core area of the cross section if the flux density has a maximum value of 0.465 Tesla.

Solution:- Given $E_1 = 240V$; $f = 50 Hz$

$N_2 = 1500$; $\phi_m = 0.00207 Wb$

$$E_2 = 4.44 \cdot f \cdot \phi_m \cdot N$$

$$\Rightarrow E_2 = 4.44 \times 50 \times 0.00207 \times 1500$$

$$\boxed{E_2 = 689.31 V}$$

we know that $\frac{E_1}{E_2} = \frac{N_1}{N_2}$

$$\Rightarrow \frac{E_1}{E_2} \cdot N_2 = N_1$$

$$N_1 = \frac{240}{689.31} \times 1500$$

$$\boxed{N_1 = 522 rpm}$$

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

$$\Rightarrow A = \frac{\phi_m}{B}$$

$$A = \frac{0.00207}{0.465}$$

$$\boxed{A = 4.45 \times 10^{-3} m^2}$$

(48)

2. Show the routing tables in R1 and R2.
3. Show DHCP server statistics.
4. Show DHCP server's pool information.
5. Analyze the packets exchanged between PC1 and the DHCP server when obtaining IP address. Write port numbers, IP address and MAC address for each packet observed.
6. Show the ping operation by pinging PC2 from PC1. Show packet capture and write port numbers, IP addresses of each Echo request and reply. Explain ping statistics.

2) A 50 KVA transformer has $N_1 : N_2 = 300:20$. The primary winding is connected to a 2200V, 50 Hz supply. calculate 1) The secondary voltage on No load 2) Approximate values of primary and secondary currents on full load 3) the maximum value of the flux

Solution :- Given $P = 50$ KVA

$N_1 = 300$; $N_2 = 20$

$E_1 = 2200V$; $f = 50$ Hz

i) $$\frac{E_2}{E_1} = \frac{N_2}{N_1} \Rightarrow E_2 = \frac{20}{300} \times 2200$$

$$\boxed{E_2 = 146.67 V}$$

ii) $$P = E_1 \cdot I_1 \Rightarrow I_1 = \frac{P}{E_1} = \frac{50 \times 10^3}{2200}$$

$$\Rightarrow \boxed{I_1 = 22.72 A}$$

similarly $P = E_2 \cdot I_2$; $I_2 = \frac{P}{E_2} = 340.90 A$

iii) $$E_1 = 4.44 \cdot f \cdot \phi_m \cdot N_1$$

$$\Rightarrow \phi_m = \frac{E_1}{4.44 \cdot f \cdot N} = \frac{2200}{4.44 \times 50 \times 300}$$

$$\boxed{\phi_m = 0.033}$$

3) The required no load ratio in a single phase 50 Hz ~~field~~ core type transformer is $\frac{6000}{150\,V}$. Find the number of turns per limb on the high voltage and low voltage side if the flux is to be about 0.06 Wb.

<u>Given :-</u> $f = 50$ HZ ; $E_1 = 6000\,V$; $E_2 = 150\,V$

$N_1 = N_2 = ?$

$$E_1 = 4.44 \cdot \phi_m \cdot f_1 \cdot N_1$$

$$N_1 = \frac{6000}{4.44 \times 0.06 \times 50} = 450.45$$

$$\boxed{N_1 \simeq 450 \text{ turns}}$$

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

$$\Rightarrow N_2 = \frac{E_2}{E_1} \times N_1 = \frac{150}{6000} \times 450$$

$$N_2 = 11.25$$

$$\Rightarrow \boxed{N_2 \simeq 11 \text{ turns}}$$

$$\text{EMF per turn} = \frac{E_1}{N_1} = 13.33$$

4) A 10 KVA, 2000 V/200 V, 50 HZ, Single phase transformer has 75 turns on its secondary. If the net cross sectional area of the core is 100 cm^2, determine

i) Rated primary and secondary currents

ii) Number of Primary turns

iii) Primary and secondary currents under half-load condition

iv) Maximum value of flux density in the core

v) EMF induced per turn on either side

50

Solution :- $P = 10\ kVA$; $E_1 = 2000\ V$; $E_2 = 200\ V$;
$f = 50\ Hz$; $N_2 = 75$; $A = 100\ cm^2$

i) To find I_1 & I_2

$$P = I_1 \cdot E_1 \Rightarrow I_1 = \frac{P}{E_1} = \frac{10 \times 10^3}{2000}$$

$$\therefore \boxed{I_1 = 5A}$$

$$P = I_2 \cdot E_2 \Rightarrow I_2 = \frac{P}{E_2} = \frac{10 \times 10^3}{200}$$

$$\boxed{I_2 = 50\ A}$$

ii) To find the no. of primary turns :-

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

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

$$\Rightarrow N_1 = \frac{75 \times 2000}{200}$$

$$\boxed{N_1 = 750}$$

iii) To find Primary & secondary currents under half load condition :-

$$P = \frac{P_{rated}}{2} = 5\ kVA$$

$$P = E_1 \cdot I_1 \Rightarrow I_1 = \frac{P}{E_1} = \frac{5 \times 10^3}{2000}$$

$$\boxed{I_1 = 2.5A}$$

$$I_2 = \frac{P}{E_2} = \frac{5 \times 10^3}{200} = 25\ A$$

iv) To find B :-

$$B = \frac{\phi_m}{A};$$

$$E_1 = 4.44 \times f \times N_1 \times \phi_m$$

$$\Rightarrow \phi_m = \frac{2000}{4.44 \times 50 \times 750} = 0.01 \text{ wb}$$

$$\therefore B = \frac{0.01}{100 \times 10^{-4}}$$

$$\boxed{B = 1.2T}$$

5) A 10 KVA, $\frac{200\text{ V}}{400\text{ V}}$ 50 Hz single phase transformer has maximum flux in core of 7.21 mWb. Determine
i) Rated Primary & secondary currents
ii) No. of Primary turns
iii) Net cross sectional area of core if $B_m = 1.4T$

Solution :- $P = 10$ KVA ; $E_1 = 200V$; $E_2 = 400V$; $\phi_m = 7.21$ mWb

i) $$I_1 = \frac{P}{E_1} = \frac{10 \times 10^3}{200} = 50 A$$

$$I_2 = \frac{P}{E_2} = \frac{10 \times 10^3}{400} = 25 A$$

ii) $$E_1 = 4.44 \times f \times N_1 \times \phi_m$$

$$\Rightarrow N_1 = \frac{200}{4.44 \times 50 \times 7.21 \times 10^{-3}}$$

$$N_1 =$$

iii) $$B_m = \frac{\phi_m}{A} \Rightarrow A = \frac{\phi_m}{B_m} = \frac{7.21 \times 10^{-3}}{1.4}$$

$$\therefore A =$$

(52)

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6. Show the ping operation by pinging PC2 from PC1. Show packet capture and write port numbers, IP addresses of each Echo request and reply. Explain ping statistics.

6) A 10 KVA single phase transformer working on a 50 HZ AC supply supplies power at a load voltage of 500 V. If the maximum value of core flux is 100 mWb and the number of primary turns is 400, determine

i) Number of secondary turns

ii) Primary induced EMF

iii) Full load primary & secondary currents

iv) Net cross-sectional area of the core if the maximum flux density is 1.4 T ?

Solution :- Given $P = 10$ KVA ; $f = 50$ HZ

$E_2 = 500V$; $\phi_m = 100$ mWb ; $N_1 = 400$

i) $E_2 = 4.44 \times f \times N_2 \times \phi_m$

$\Rightarrow N_2 = \frac{500}{4.44 \times 50 \times 100 \times 10^{-3}}$

$N_2 =$

ii) $\frac{E_1}{E_2} = \frac{N_1}{N_2} \Rightarrow E_1 = 500 \times \frac{400}{N_2} =$

iii) $I_1 = \frac{P}{E_1} = \frac{10 \times 10^3}{E_1} =$

$I_2 = \frac{P}{E_2} = \frac{10 \times 10^3}{E_2} =$

iv) $A = \frac{\phi_m}{B}$

$A = \frac{100 \times 10^{-3}}{1.4}$

$A =$

EMF Equations of Transformer

Let E_1 be rms value of induced EMF in primary

Let E_2 be rms value of induced EMF in secondary

N_1 = number of turns in primary

N_2 = number of turns in secondary

ϕ_m = peak value of magnetic flux

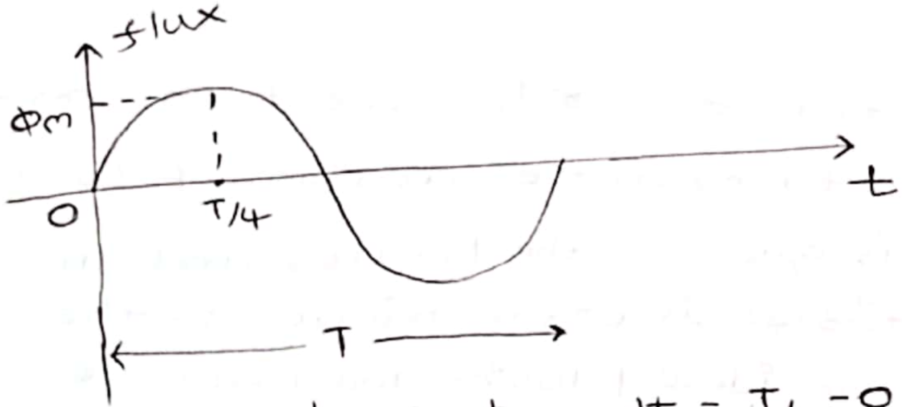
From Faraday's law of electro magnetic induction, average value of EMF is given by

$$E_{avg} = N \cdot \frac{d\phi}{dt}$$

$d\phi \rightarrow$ Maximum change of flux

$dt \rightarrow$ Total time required

→ Since applied voltage is alternating in nature, the flux in the circuit is also alternating.



$$d\phi = \phi_m - 0 = \phi_m \; ; \; dt = T/4 - 0 = \frac{1}{4f}$$

$$\therefore \quad E_{avg} = \frac{N \cdot \phi m}{(1/4f)}$$

$$E_{avg} = N \cdot 4f \cdot \phi m$$

→ Form factor of any signal is given by :-

$$FF = \frac{\text{rms value}}{\text{average value}}$$

(54) → for a sinusoidal signal :- $V_{rms} = \frac{V_m}{\sqrt{2}}$

$$V_{avg} = \frac{2V_m}{\pi}$$

∴ Form factor $= \frac{\frac{V_m}{\sqrt{2}}}{\frac{2V_m}{\pi}} = \frac{V_m}{\sqrt{2}} \times \frac{\pi}{2V_m} = \frac{\pi}{2\sqrt{2}} = 1.11$

$$E_{1_{rms}} = 1.11 * E_{avg}$$

$$E_{1_{rms}} = 1.11 * 4 * \Phi_m * f * N_1$$

$$E_1 = 4.44 \, \Phi_m f N_1$$

$$E_2 = 4.44 . \Phi_m f . N_2$$

$$\frac{E_1}{E_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

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

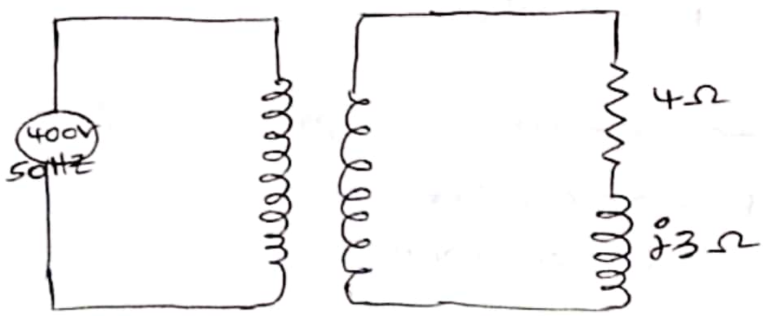
7) An iron-cored transformer has 200 turns on the primary and 100 turns on the secondary. A supply of 400V, 50 HZ is given to the primary and an impedance of $(4+j3)\Omega$ is connected across the secondary. Assume ideal behavior and calculate

a) voltage and current through the load

b) the primary current and

c) the power taken from the supply

Solution



$N_1 = 200$; $N_2 = 100$; $E_1 = 400\,V$; $E_2 = ?$; $f = 50\,Hz$

$$V_L = E_2 = \frac{N_2}{N_1} \times E_1$$

$$E_2 = \frac{100}{200} \times 400 = 200\,V$$

$$I_L = \frac{V_L}{Z} = \frac{200}{4+j3} = \frac{200}{\sqrt{4^2+3^2} \cdot \tan^{-1}(3/4)}$$

$$I_L = 40 \angle -36.86^\circ$$

ii) To find primary current

$$\cancel{\frac{E_2}{E_1} = \frac{I_2}{I_1} \Rightarrow I_1 = \frac{E_1}{E_2} \cdot I_2}$$

$$\cancel{\Rightarrow I_1 = \frac{400}{200} \times 40 \Rightarrow I_1 =}$$

$$\frac{E_1}{E_2} = \frac{I_2}{I_1} \Rightarrow I_1 = \frac{E_2}{E_1} \times I_2$$

$$\therefore \quad I_1 = \frac{200}{400} \times 40 = 20\,A$$

iii) Power taken from the supply :-

$$P = E_1 \times I_1 = 20 \times 400 = 8\,KVA$$

8) The maximum flux density in the core of a 1100/200 V, 50 HZ, 100 KVA transformer is 3.5 T. If the EMF per turn is 5.5 V, calculate :

i) the area of cross section of the core

ii) the number of turns of primary & secondary windings

iii) Rated primary & secondary currents at full load.

iv) Rated primary & secondary currents at 25% load

Solution :- $B_m = 3.5\,T$; $E_1 = 1100\,V$; $E_2 = 200\,V$; $P = 100\,KVA$

$$E_1/N_1 = E_2/N_2 = 5.5\,V$$