QUICK QUIZ (POLL)

Prim Sec.

A single-phase, 150-kVA, 1100-V/400-V transformer has 100 turns on the secondary winding. The number of turns on its primary winding will be

(a) 5500 (b) 2200
(c) 550 (d) 275

- Ans D

In case Ans. is in decimals

e.g., 275.12
275.35

Then, value taken is 276 turns

∴ Half turn not possible

$$\frac{N_1}{N_2} = \frac{V_1}{V_2}$$

$$\Rightarrow \frac{N_1}{100} = \frac{1100}{400}$$

$$\Rightarrow N_1 = \frac{1100}{4}$$

$$= 275 \text{ turns.}$$

Practice Problem 1

A 250 kVA, 11 000 V/400 V, 50 Hz single-phase transformer has 80 turns on the secondary. Calculate

(a) the approximate values of the primary and secondary currents;

(b) the approximate number of primary turns;

(c) the maximum value of the flux

Full load, prim. current, $I_p = \dfrac{\text{Power}}{\text{voltg}}$

$$\Rightarrow I_p = \frac{250 \times 10^3}{11000} = \frac{250}{11} = 22.727\ A$$

& lly, $I_s = \dfrac{\text{Powr}}{\text{voltg}} = \dfrac{250 \times 10^3}{400} = 625\ A.$

(B) $N_1 = \dfrac{V_1}{V_2} \times N_2 = \dfrac{11000}{400} \times 80 = 2200$

(a) Full-load primary current

$$\simeq \frac{250 \times 1000}{11\,000} = 22.7 \text{ A}$$

and full-load secondary current

$$= \frac{250 \times 1000}{400} = 625 \text{ A}$$

(b) No. of primary turns

$$\simeq \frac{80 \times 11\,000}{400} = 2200$$

(c) From expression [35.5]

$$400 = 4.44 \times 80 \times 50 \times \Phi_m$$

$$\Phi_m = 22.5 \text{ mWb}$$

Practice Problem 1

A 250 kVA, 11 000 V/400 V, 50 Hz single-phase transformer has 80 turns on the secondary. Calculate

(a) the approximate values of the primary and secondary currents;

(b) the approximate number of primary turns;

(c) the maximum value of the flux

(c) Emf Eqn of a Xsfmr:

$$e = 4.44 N f \phi_m$$

$$\Rightarrow \phi_m = \frac{e}{4.44 N f} = \frac{400}{4.44 \times 80 \times 50} = 0.022525 = 22.52 \text{ mWb}$$

(Sec. Side)

$$(\text{or}) \quad \frac{11000}{4.44 \times 2200 \times 50} = 0.022525 = 22.52 \text{ mWb}$$

(Prim. Side)

Practice Problem 2

A single-phase, 50-Hz transformer has 30 primary turns and 350 secondary turns. The net cross-sectional area of the core is 250 cm^2. If the primary winding is connected to a 230-V, 50-Hz supply, calculate (*a*) the peak value of flux density in the core, (*b*) the voltage induced in the secondary winding, and (*b*) the primary current when the secondary current is 100 A. (Neglect losses.)

Solution

(*a*) The peak value of the flux in the core is given as

$$\Phi_m = \frac{E_1}{4.44 f N_1} = \frac{230}{4.44 \times 50 \times 30} = 0.034534 \text{ Wb}$$

Therefore, the peak value of the flux density in the core is

$$B_m = \frac{\Phi_m}{A} = \frac{0.034534}{250 \times 10^{-4}} = \mathbf{1.3814T}$$

(*b*) The voltage induced in the secondary winding is

$$E_2 = E_1 \times \frac{N_2}{N_1} = 230 \times \frac{350}{30} = 2683.33 \text{ V} = \mathbf{2.683 \text{ kV}}$$

(*c*) The primary current is

$$I_1 = I_2\left(\frac{N_2}{N_1}\right) = 100 \times \left(\frac{350}{30}\right) = 1166.67 \text{ A} \approx \mathbf{1.167 \text{ kA}}$$

Practice Problem 2

A single-phase, 50-Hz transformer has 30 primary turns and 350 secondary turns. The net cross-sectional area of the core is 250 cm^2. If the primary winding is connected to a 230-V, 50-Hz supply, calculate (*a*) the peak value of flux density in the core, (*b*) the voltage induced in the secondary winding, and (*b*) the primary current when the secondary current is 100 A. (Neglect losses.)

Practice Problem 3

K

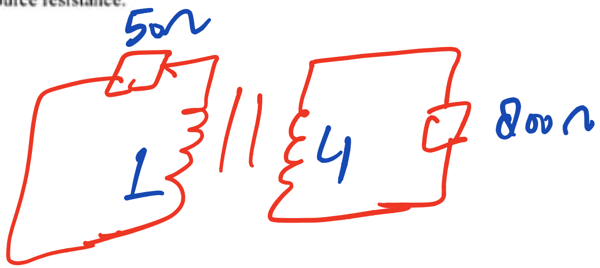
A source with an output resistance of 50 Ω is required to deliver power to a load of 800 Ω. Find the turns-ratio of the transformer to be used for maximizing the load power.

Solution For delivering maximum power to the load, the equivalent resistance must be equal to the source resistance. This requires a resistance of 50 Ω looking into the primary of the transformer. That is,

$$R_{eq} = R_L/K^2 \quad \text{or} \quad 50 = 800/K^2 \quad \Rightarrow \quad K = \sqrt{800/50} = \sqrt{16} = 4$$

Thus,

$$K = \frac{N_2}{N_1} = 4$$



$$\left[K = \frac{N_2}{N_1}\right] \quad \text{and} \quad Z_S = \frac{Z_L}{K^2}$$

$$\Rightarrow 50 = \frac{800}{K^2} \qquad \Rightarrow K^2 = \frac{800}{50} = 16$$

$$\Rightarrow \underline{\underline{K = 4}}.$$

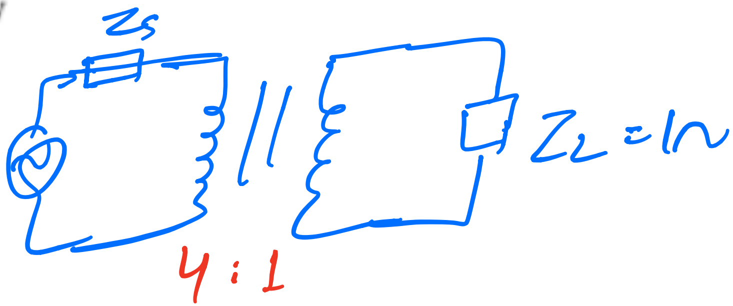
QUICK QUIZ (POLL)

A single-phase transformer has a turns-ratio of 4 : 1. If the secondary winding has a resistance of 1 ohm, this resistance as referred to the primary will be

(*a*) 16 Ω (*b*) 4 Ω

(*c*) 0.25 Ω (*d*) 0.0625 Ω

- Ans A



$$Z_s = \frac{Z_L}{K^2}$$

$$\Rightarrow \frac{N_2}{N_1} = \frac{1}{4} = K$$

$$\Rightarrow Z_s = \frac{1\Omega}{\left(\frac{1}{4}\right)^2} = \frac{1\Omega}{\frac{1}{16}}$$

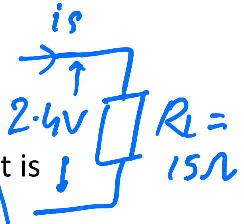
$$\Rightarrow Z_s = 16\,\Omega$$

Practice Problem 4

A transformer has 500 turns of the primary winding and 10 turns of the secondary winding.

a) Determine the secondary voltage if the secondary circuit is open and the primary voltage is 120 V.

b) Determine the current in the primary and secondary winding, given that the secondary winding is connected to a resistance load 15 Ω?



Sol:

$$U_2 = \frac{10}{500} \cdot 120\ \mathrm{V} = 2.4\ \mathrm{V}$$

When calculating the primary current, we assume that this is an ideal transformer, i.e. that it is lossless. In this case, for the electric power on the coils it applies:

① $\boxed{P_{out} = P_{in}}$

$$P_{out} = \frac{V^2}{R} = \frac{(2.4)^2}{15} = 0.384 \text{ Watts}$$

$$\Rightarrow 0.384 = V_s I_s$$

$$\Rightarrow I_s = 0.384/2.4 = 0.16A$$

$$I_s = \frac{2.4}{15} = 0.16 \text{ Amp}$$

Numerical substitution:

Primary current:

$$I_1 = \frac{(2.4)^2}{120 \cdot 15}\ \mathrm{A} = 3.2\ \mathrm{mA}$$

Secondary current:

$$I_2 = \frac{2.4}{15}\ \mathrm{A} = 0.16\ \mathrm{A}$$

② Then, $I_p = \frac{N_s}{N_p} \times I_s = \frac{10}{500} \times 0.16 = 0.0032 = 3.2\ \mathrm{mA}$

QUICK QUIZ (POLL)

If the full-load copper loss of a transformer is 100 W, its copper loss at half load will be

(*a*) 200 W (*b*) 100 W

(*c*) 50 W (*d*) 25 W ✓

Copper loss $= I^2R$

(1) $I^2R = 100\,W$

(2) Half load → current is $\frac{I}{2}$

$\left(\frac{I}{2}\right)^2 R = \frac{1}{4} I^2 R = \frac{1}{4} \times 100\,W$

$= 25\,W$

QUICK QUIZ (POLL)

If the full-load core loss of a transformer is 100 W, its core loss at half load will be

(*a*) 200 W (*b*) 100 W

(*c*) 50 W (*d*) 25 W

Core losses are const. &

∌ vary with load.

QUICK QUIZ (POLL)

A transformer operates at maximum efficiency, when

(*a*) its hysteresis loss and eddy-current loss are minimum

(*b*) the sum of its hysteresis loss and eddy-current loss is equal to its copper loss

(*c*) the power factor of the load is leading

(*d*) its hysteresis loss is equal to its eddy-current loss

when $W_{iron} = W_{copper}$

Hysteresis   Eddy Current

$\Rightarrow \boxed{W_{cu} = W_h + W_e}$

QUICK QUIZ (POLL)

A distribution transformer should be selected on the basis of its

(a) all-day efficiency
(b) regulation
(c) commercial efficiency
(d) all the above

because :-

Core loss = const

copper loss = vble & depends on the load consumers are connecting !

→ varies

max. at night

less during day.

QUICK QUIZ (POLL)

Cooling of transformers is required so as to

(*a*) increase the efficiency

(*b*) reduce the losses

(*c*) reduces the humming

(*d*) dissipate the heat generated in the windings