Numerical Problems

Important formulas:

- **Ratio formula of transformer** $\frac{V_s}{V_p} = \frac{N_s}{N_p}$
- **Equation of ideal transformer** $V_p I_p = V_s I_s$

15.1 A transformer is needed to convert a main 240 V supply into a 12 V supply. If there are 2000 turns on the primary coil, then find the number of turns on the secondary coil. ***(ALP)***

Given Data

$$Voltage\ across\ primary\ coil = V_p = 240\ V$$
$$Voltage\ across\ secondary\ coil = V_s = 12\ V$$
$$No.of\ turns\ on\ primary\ coil = N_p = 2000$$

To Find

$$No.of\ turns\ on\ secondary\ coil = N_s = ?$$

Solution

By using ratio formula of transformer

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$
$$N_s = \frac{V_s N_p}{V_p}$$
$$N_s = \frac{(12)(2000)}{240}$$
$$\boldsymbol{N_s = 100\ turns}$$

15.2 A step-up transformer has a turn ratios of 1 : 100. An alternating supply of 20 V is connected across the primary coil. What is the secondary voltage? ***(ALP)***

Given Data

$$Turn\ ratio\ of\ step\ up\ transformer = \frac{N_p}{N_s} = 1 : 100$$
$$No.of\ turns\ on\ primary\ coil = N_p = 1$$
$$No.of\ turns\ on\ secondary\ coil = N_s = 100$$
$$Voltage\ across\ primary\ coil = V_p = 20\ V$$

To Find

$$Voltage\ across\ secondary\ coil = V_s = ?$$

Solution

By using ratio formula of transformer

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$
$$V_s = \frac{N_s V_p}{N_p}$$
$$V_s = \frac{(100)(20)}{1}$$
$$\boldsymbol{V_s = 2000\ V}$$

15.3 A step-down transformer has a turns ratio of 100 : 1. An ac voltage of amplitude 170 V is applied to the primary. If the current in the primary is 1.0 mA, what is the current in the secondary? ***(ALP)***

Given Data

$$Turn\ ratio\ of\ step\ down\ transformer = \frac{N_p}{N_s} = 100 : 1$$
$$No.of\ turns\ on\ primary\ coil = N_p = 100$$
$$No.of\ turns\ on\ secondary\ coil = N_s = 1$$
$$Voltage\ across\ primary\ coil = V_p = 170\ V$$
$$Current\ in\ the\ primary\ coil = I_p = 1.0\ mA$$
$$I_p = 1.0 \times 10^{-3} A$$

To Find

$$Current\ in\ the\ secondary\ coil = I_s = ?$$

Solution

By using ratio formula of transformer, we find V_s

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$
$$V_s = \frac{N_s V_p}{N_p}$$
$$V_s = \frac{(1)(170)}{100}$$
$$V_s = 1.7\ V$$

Now, by using equation of ideal transformer

$$V_p I_p = V_s I_s$$
$$I_s = \frac{V_p I_p}{V_s}$$
$$I_s = \frac{(170)(1.0 \times 10^{-3})}{1.7}$$
$$\boldsymbol{I_s = 0.1\ A}$$

15.4 A transformer, designed to convert the voltage from 240 V a.c mains to 12 V, has 4000 *turns* on the primary coil. How many turns should be on the secondary coil? If the transformer were 100% efficient, what current would flow through the primary coil when the current in the secondary coil was 0.4 A? ***(ALP)***

Given Data

$$Voltage\ across\ primary\ coil = V_p = 240\ V$$
$$Voltage\ across\ secondary\ coil = V_s = 12\ V$$
$$No.of\ turns\ on\ primary\ coil = N_p = 4000$$
$$Current\ in\ the\ secondary\ coil = I_s = 0.4\ A$$

To Find

$$No.of\ turns\ on\ secondary\ coil = N_s = ?$$
$$Current\ in\ the\ primary\ coil = I_p = ?$$

Solution

By using ration formula of transformer

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$
$$N_s = \frac{V_s N_p}{V_p}$$
$$N_s = \frac{(12)(4000)}{240}$$
$$\boldsymbol{N_s = 200}$$

Now, by using equation of ideal transformer

$$V_p I_p = V_s I_s$$
$$I_p = \frac{V_s I_s}{V_p}$$
$$I_p = \frac{(12)(0.4)}{240}$$
$$\boldsymbol{I_p = 0.02\ A}$$

15.5 A power station generates $500\ MW$ of electrical power which is fed to a transmission line. What current would flow in the transmission line, if the input voltage is $250\ kV$?

Given Data

$$Power\ generated = P = 500\ MW$$
$$P = 500 \times 10^6\ W$$
$$Input\ Voltage = V = 250\ kV$$
$$V = 250 \times 10^3\ V$$

To Find

$$Amount\ of\ current\ = I = ?$$

Solution

By using formula of power

$$P = IV$$
$$I = \frac{P}{V}$$
$$I = \frac{500 \times 10^6}{250 \times 10^3}$$
$$I = 2000\ A$$
$$\boldsymbol{I = 2 \times 10^3\ A}$$

Examples

15.1 If a transformer is used to supply voltage to a $12\ V$ model train which draws a current of $0.8\ A$. Calculate the current in the primary if the voltage of the a.c. source is $240\ V$. *(ALP)*

Given Data

$$Voltage\ across\ primary\ oil = V_p = 240\ V$$
$$Voltage\ across\ secondary\ coil = V_s = 12\ V$$
$$Current\ in\ the\ secondary\ coil = I_s = 0.8\ A$$

To Find

$$Current\ in\ the\ primary\ coil = I_p = ?$$

Solution

Now, by using equation of ideal transformer

$$V_p I_p = V_s I_s$$
$$I_p = \frac{V_s I_s}{V_p}$$
$$I_s = \frac{(12)(0.8)}{240}$$
$$\boldsymbol{I_s = 0.04\ A}$$