

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

$$\text{Voltage across primary coil} = V_p = 240 \text{ V}$$

$$\text{Voltage across secondary coil} = V_s = 12 \text{ V}$$

$$\text{No. of turns on primary coil} = N_p = 2000$$

To Find

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

Solution

By using ratio formula of transformer

$$\begin{aligned}\frac{V_s}{V_p} &= \frac{N_s}{N_p} \\ N_s &= \frac{V_s N_p}{V_p} \\ N_s &= \frac{(12)(2000)}{240} \\ N_s &= 100 \text{ turns}\end{aligned}$$

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

$$\text{Turn ratio of step up transformer} = \frac{N_p}{N_s} = 1 : 100$$

$$\text{No. of turns on primary coil} = N_p = 1$$

$$\text{No. of turns on secondary coil} = N_s = 100$$

$$\text{Voltage across primary coil} = V_p = 20 \text{ V}$$

To Find

$$\text{Voltage across secondary coil} = V_s = ?$$

Solution

By using ratio formula of transformer

$$\begin{aligned}\frac{V_s}{V_p} &= \frac{N_s}{N_p} \\ V_s &= \frac{N_s V_p}{N_p} \\ V_s &= \frac{(100)(20)}{1} \\ V_s &= 2000 \text{ V}\end{aligned}$$

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

$$\text{Turn ratio of step down transformer} = \frac{N_p}{N_s} = 100 : 1$$

$$\text{No. of turns on primary coil} = N_p = 100$$

$$\text{No. of turns on secondary coil} = N_s = 1$$

$$\text{Voltage across primary coil} = V_p = 170 \text{ V}$$

$$\text{Current in the primary coil} = I_p = 1.0 \text{ mA}$$

$$I_p = 1.0 \times 10^{-3} \text{ A}$$

To Find

$$\text{Current in the secondary coil} = I_s = ?$$

SolutionBy using ratio formula of transformer, we find V_s

$$\begin{aligned}\frac{V_s}{V_p} &= \frac{N_s}{N_p} \\ V_s &= \frac{N_s V_p}{N_p} \\ V_s &= \frac{(1)(170)}{100} \\ V_s &= 1.7 \text{ V}\end{aligned}$$

Now, by using equation of ideal transformer

$$\begin{aligned}V_p I_p &= V_s I_s \\ I_s &= \frac{V_p I_p}{V_s} \\ I_s &= \frac{(170)(1.0 \times 10^{-3})}{1.7} \\ I_s &= 0.1 \text{ A}\end{aligned}$$

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

$$\text{Voltage across primary coil} = V_p = 240 \text{ V}$$

$$\text{Voltage across secondary coil} = V_s = 12 \text{ V}$$

$$\text{No. of turns on primary coil} = N_p = 4000$$

$$\text{Current in the secondary coil} = I_s = 0.4 \text{ A}$$

To Find

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

$$\text{Current in the primary coil} = I_p = ?$$

Solution

By using ratio formula of transformer

$$\begin{aligned}\frac{V_s}{V_p} &= \frac{N_s}{N_p} \\ N_s &= \frac{V_s N_p}{V_p} \\ N_s &= \frac{(12)(4000)}{240} \\ N_s &= 200\end{aligned}$$

Now, by using equation of ideal transformer

$$\begin{aligned}V_p I_p &= V_s I_s \\ I_p &= \frac{V_s I_s}{V_p} \\ I_p &= \frac{(12)(0.4)}{240} \\ I_p &= 0.02 \text{ A}\end{aligned}$$

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

$$\begin{aligned} \text{Power generated} &= P = 500 \text{ MW} \\ &= 500 \times 10^6 \text{ W} \\ \text{Input Voltage} &= V = 250 \text{ kV} \\ &= 250 \times 10^3 \text{ V} \end{aligned}$$

To Find

$$\text{Amount of current} = I = ?$$

Solution

By using formula of power

$$\begin{aligned} P &= IV \\ I &= \frac{P}{V} \\ I &= \frac{500 \times 10^6}{250 \times 10^3} \\ I &= 2000 \text{ A} \\ I &= 2 \times 10^3 \text{ A} \end{aligned}$$

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

$$\begin{aligned} \text{Voltage across primary coil} &= V_p = 240 \text{ V} \\ \text{Voltage across secondary coil} &= V_s = 12 \text{ V} \\ \text{Current in the secondary coil} &= I_s = 0.8 \text{ A} \end{aligned}$$

To Find

$$\text{Current in the primary coil} = I_p = ?$$

Solution

Now, by using equation of ideal transformer

$$\begin{aligned} V_p I_p &= V_s I_s \\ I_p &= \frac{V_s I_s}{V_p} \\ I_p &= \frac{(12)(0.8)}{240} \\ I_p &= 0.04 \text{ A} \end{aligned}$$