Numerical Problems

15.1 A transformer is needed to convert a mains 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.

Answer

Input voltage, $V_p = 240$ V

Output voltage, $V_s = 12$ V

Turns on primary coil, $N_p = 2000$

Turns on secondary coil, N_s =?

By the formula of turn ratio in transformer,

We have:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

or $$N_s = \frac{V_s}{V_p} \times N_p$$

Putting the values, we get:

$$N_s = \frac{12}{240} \times 2000$$

$$\boxed{N_s = 100 \text{ turns}}$$

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

Answer

$$\begin{cases} \text{As the tum ratio is given, i. e. } N_p : N_s \\ \text{in step} - \text{ up transformer, or } 1:100 \end{cases}$$

It means, that: $\frac{N_s}{N_p} = \frac{100}{1}$

Also, input voltage, $V_p = 20$ V

Output voltage, V_s =?

Applying the formula:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Putting the values, we get:

$$\frac{V_s}{20} = \frac{100}{1}$$

$V_s = 20 \times 100$

$\boxed{V_s = 2000 \text{ volts}}$

15.3 A step-down transformer has a turns ratio of 1: 100. An A.C 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?

Answer

As a step-down transformer is given; So:

N_p: N_s

It means that, 100 :1

Therefore, $\frac{N_s}{N_p} = \frac{1}{100}$

Input A.C voltage, $V_p = 170$ V

Output A.C voltage, V_s =?

Input current, $I_p = 1$mA

$= 1 \times 10^{-3}$ A

Output current: Is =?

We know that

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

or $$V_s = \frac{N_s}{N_p} \times V_p$$

putting the values, we get:

$$V_s = \frac{1}{100} \times 170$$

or $$V_s = 1.7\ V$$

Now, applying energy conservation formula

$$V_pI_p = V_sI_s$$

⇒ $$I_s = \frac{V_pI_s}{V_s}$$

Putting the values, we get:

$$I_s = \frac{170 \times 10^{3}}{1.7}$$

or $$\boxed{I_s = 0.1A}$$

15.1 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?

Answer

Input voltage, V_p = 240 V

Output voltage, V_s = 12 V

Input current, I_p =? .

Output current, I_s = 0.4 A

Turns on primary coil, N_p = 4000

Turns on secondary coil, N_s =?

We know that

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

⇒ $$N_s = \frac{V_s}{V_p} \times N_p$$

Putting the values, we get:

$$N_s = \frac{12}{240} \times 4000$$

or $\boxed{N_s = 200 \text{ turns}}$

Applying energy conservation formula

$$V_p I_p = V_s I_s$$

⇒ $$I_p = \frac{V_s I_s}{V_p}$$

Putting the values, we get:

$$I_p = \frac{12 \times 0.4}{240}$$

or $\boxed{I_p = 0.02A}$

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?

Answer

Input power, P= 500 MW

$= 500 \times 10^6 W$

Input current, I_p =?

Input voltage, V_p =250 kv

$=250 \times 10^3 V$

We know that,

$$P = V_p I_p$$

$$\Rightarrow \quad I_p = \frac{P}{V_p}$$

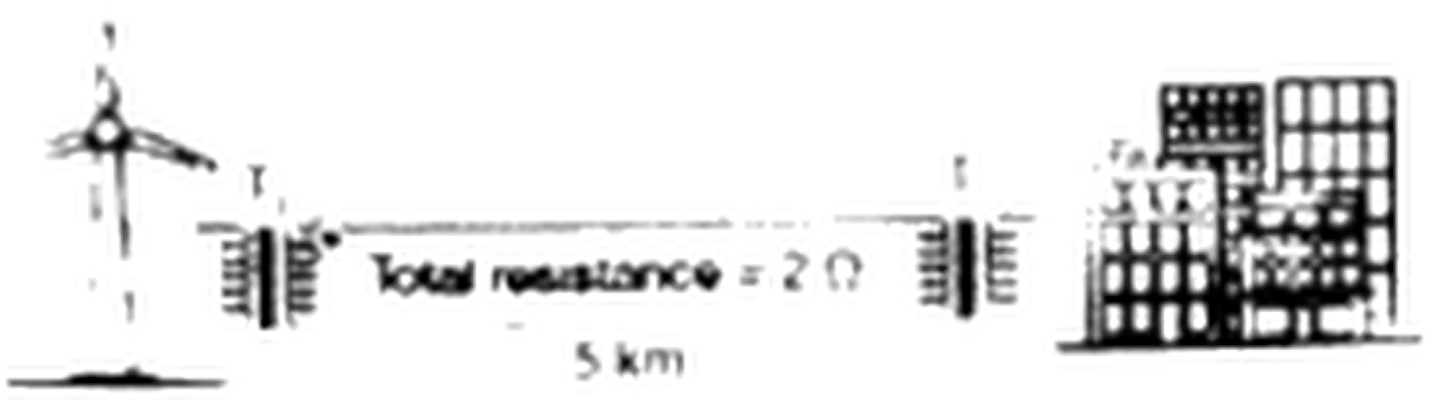
Putting the values, we get:

$$I_p = \frac{500 \times 10^6}{250 \times 10^3}$$

or $I_p = 200A$

or $\boxed{I_p = 2x\ 10^3 A}$

15.6 The diagram shows a wind turbine which runs a 150-kW generator with an output voltage of 1000 V. the voltage is increased by transformer T_1 to 10,000 V for transmission to a town 5 km away through power lines with a total resistance of 2Ω. Another transformer, T2, at the town reduces the voltage to 250 V. Assume that the transformers are 'ideal'.



When the system is running at full power:

a) What is the current in the power line?

b) What is the voltage drop and power loss along the power line? Also find the voltage at the input to the town transformer.

Answer

Power given to transmission line, P= 150 kw

$$= 150 \times 10^3 \text{ W}$$

Output voltage from transformer, T_1, V_s = 10000 V

Resistance in transmission line, R = 2 Ω

Current through transmission line, I_s =?

a) We know that $P = V_s I_s$

or $I_s = \frac{P}{V_s}$

Putting the values, we get:

$$I_s = \frac{150 \times 10^3}{10000}$$

$$\boxed{I_s = 15A}$$

b) i): Also, we know that

$$V = IR$$

⇒ $V = 15 \times 2$

$$\boxed{V = 30 \text{ volts}}$$

It shows that 30 V voltage will be drop along the power line.

ii) Power along transmission line, P' =?

We know that,

$$P' = VI$$

$$= 30 \times 15$$

$$\boxed{P' = 450 \text{ W}}$$

It shows that 450 W power will be lost along the transmission line.

iii) Voltage given to transmission line, = 10000 V

Voltage lost along transmission line = 30 V

So,

Voltage at input of T_2 = 1000-30

= 9970 V

$$\boxed{V' = 9970\ V}$$