UNIT 3
<u>Electromagnetic Induction</u>

09/10/2020 – Class 23

<u>**Assignment Answer**</u>

Answer the following

a) In which part of a step up transformer is the number of turns of coils greater? **Secondary.**

b) What do you know about the thickness of coils in this part? **Thin wires are used.**

c) In which part of a step down transformer is the number of turns of coils less? **Secondary.**

d) What do you know about the thickness of coils in this part? **Thick wires are used.**

<u>**Activity 1**</u>

Analyse the table and find the answers.

Transformer	Primary			Secondary		
	Total Voltage V_p	Number of turns N_p	Voltage in one turn (e) V_p / N_p	Total Voltage V_s	Number of turns N_s	Voltage in one turn (e) V_s / N_s
T1	500 V	100	5	50 V	10	5
T2	20 V	10	2	200 V	100	2 V
T	$N_p \times e$	N_p	e	$N_s \times e$	N_s	e

<u>**Discussion**</u>

- What is the primary voltage of transformer T1? **500 V**
- How many turns are in the primary of transformer T1? **100**
- Voltage in one turn of the primary coil of transformer T1? **500/100 = 5 V**
- What is the secondary voltage of transformer T1? **50 V**
- How many turns are in the secondary coil of transformer T1? **10**
- Voltage in one turn of the secondary coil of transformer T1? 50 /10 = **5 V**
- What is the primary voltage of the transformer T2? **20 V**
- How many turns are in the primary of transformer T2? **10**
- Voltage in one turn of the primary coil of transformer T2? 20/10 = **2 V**
- What is the secondary voltage of the transformer T2? **200 V**
- How many turns are in the secondary of transformer T2? **100**
- Voltage in one turn of the secondary coil of transformer T2? 200/100 = **2 V**
- What is the relation between the voltages of one turn in the primary coil and secondary coil of a transformer? **They are equal.**
- If N_p is the number of turns in the primary coil and **e** is the voltage in one turn, then what is the total voltage in the primary(V_p)? $N_p \times e$
- If N_s is the number of turns in the secondary coil and **e** is the voltage in one turn, then what is the total voltage in the secondary(V_s)? $N_s \times e$

<u>**Inference**</u>

- Voltage in one turn of the primary of a transformer (**e**) = V_p / N_p
- Voltage in one turn of the secondary of a transformer (**e**) = V_s / N_s
- The emf in each turn of the primary and the secondary coils of a transformer is same.

$$(V_s / N_s = V_p / N_p)$$

- Total voltage in the primary of a transformer (V_p) = $N_p \times e$
- Total voltage in the secondary of a transformer (V_s) = $N_s \times e$

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Questions

a) What kind of transformers are T1 and T2?

     T1 – **Step down transformer.**

     T2 – **Step up transformer.**

b) What is the voltage in one turn when 500 V is given as input in T1 primary? **500 /100 = 5 V**

c) Is there a change in one turn voltage of the same transformer when the output voltage decreases to 50 V? **No change.**

d) Is there a voltage change in each one turn of the primary and secondary in the step up transformer T2? **No change.**

e) How the ratio of voltages to the number of turns in each of the transformers, primary and secondary is related? Write this ratio in mathematical form.

  The emf in one turn of the primary = The emf in one turn of the secondary

$$V_s / N_s = V_p / N_p$$

  Rearrange the equation,

$$\boxed{V_s / V_p = N_s / N_p}$$

   V_s = Secondary Voltage

   V_p = Primary Voltage

   N_s = Number of turns in the secondary.

   N_p = Number of turns in the primary.

f) What could be the reason for using thicker wire windings in the primary of a step up transformer and the secondary of a step down transformer?

Discussion

- In an ideal transformer, what is the relation between the power in the primary and secondary? **They are equal. (V_p X I_p = V_s X I_s)**
- In a step up transformer, which coil has more voltage? **Secondary, (V_s > V_p)**
- So in a step up transformer, current in which coil is higher? **Primary, (I_p > I_s)**
- When current increases, what about the heat produced? **Increases.**
- How can we reduce the heat produced in the coil? **By decreasing the resistance.**
- To decrease the resistance, what to do? **Increases the thickness.**
- In a step down transformer, which coil has more voltage? **Primary, (V_p > V_s)**
- So in a step down transformer, current in which coil is higher? **Secondary, (I_s > I_p)**

  The primary and secondary power of a transformer will be equal. Therefore the current in the primary of the step up transformer and the secondary of the step down transformer will be higher. So thicker wires will be used to prevent the coil from overheating. Thicker wires have less resistance.

Activity 2

  In a transformer without any loss in power, there are 5000 turns in the primary and 250 turns in the secondary. The primary voltage is 120 V and the primary current is 0.1 A. Find the voltage and current in the secondary.

    No of turns in the primary (**N_p**)= 5000

    No of turns in the secondary (**N_s**) = 250

    Primary voltage (**V_p**)= 120 V

    Primary Current (**I_p**) = 0.1 A

    Secondary voltage (**V_s**) =?

Secondary current(I_s)=?

$$V_s / V_p = N_s / N_p$$
$$V_s / 120 = 250 / 5000$$
$$V_s = (250/5000) \times 120 = \textbf{6 V}$$

Secondary voltage (V_s = **6 V**

$$V_p \times I_p = V_s \times I_s$$
$$120 \text{ V} \times 0.1 \text{ A} = 6 \text{ V} \times I_s$$
$$I_s = (120 \times 0.1) / 6 = 2 \text{ A}$$

Secondary current (I_s) = **2 A**

- Step up transformer **increases** the voltage and **decreases** the current.
- Step down transformer **decreases** the voltage and **increases** the current.

Assignment

1. Categorise the following relations appropriately as step up or step down transformers.

- $V_s > V_p$
- $V_s < V_p$
- $I_s < I_p$

- $I_s > I_p$
- $\dfrac{N_s}{N_p} < 1$
- $\dfrac{N_s}{N_p} > 1$

2. Transformer is a device used to change the voltage without changing the power.
Differentiate the statements given below, suitable to the step up and step down transformer.

a) Number of turns in the primary coil is lesser than Secondary coil.
b) Number of turns in the primary coil is greater than Secondary coil.
c) Input voltage is greater than output voltage.
d) Output voltage is greater than input voltage.
e) Thickness of primary coil is greater than secondary coil.
f) Thickness of secondary coil is greater than primary coil,
g) Input current is greater than output current.
h) Output current is greater than input current.