Unit 17

ELECTROMAGNETISM

Q. What is the magnetic effects of electric current?

Ans. Magnetic effects of electric current

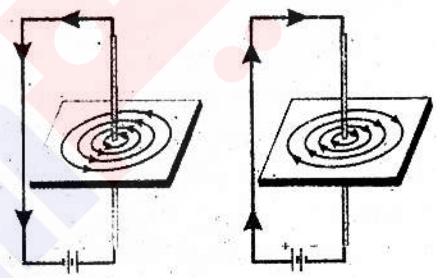
"When current passes through a conductor, a magnetic field is produced in the space around it."

Straight wire:

If current passes through straight wire then lines of force of this magnetic field would be in the form of concentric circles. The lines of force can be traced on card board with the compass needle. The direction of lines of force can be determined by right hand rule.

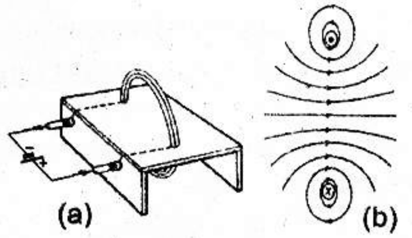
Right Hand Rule:

According to right hand rule **"grasp the current carrying conductor in right hand with the thumb being stretched in the direction of current. The fingers would curl in the direction of magnetic lines of force"**. This rule shows that if the current is flowing through wire from bottom end to top then the direction of lines of force would be anti-clockwise. On the other hand, if the current is flowing from top towards the bottom, it would be clockwise.



COIL:

A coil of few turns of wire is shown in fig. Its two ends are connected with a battery so that a current is passing through it. In fig. vertical cross section of a single turn of this coil has been shown by a small circle.



Direction of current:

The direction of current has been indicated by placing a dot or a sign of multiplication in these circles. A dot indicates that the current is directed out of the plane of the paper, i.e., it is flowing towards us where as a sign of cross (X) would mean that the current is directed into the paper i.e.; it is flowing away from us.

Lines of force of coil:

These lines are straight and parallel in a small region near the centre of the coil and are directed perpendicular to its plane. They are approximately circular near the wire. Thus the field is uniform in a small area surrounding the centre of the coil. In the remaining portion it is non-uniform.

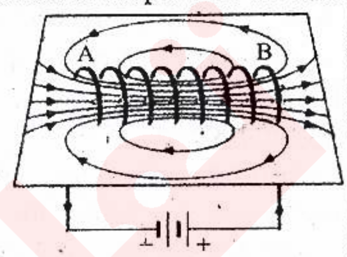
Magnetic field of a current carrying solenoid:

Solenoid:

A solenoid is a closely wound cylindrical coil of insulated wire.

Lines of Force:

The lines emerge out from one end of the solenoid and after encircling around, enter into it through the other end. Inside the solenoid, the lines of force are parallel and all point in the same direction. It can be seen that these lines resemble the pattern of the lines of force due to a bar magnet. On the basis of this resemblance, we can say that one end of the solenoid behaves like a north pole and the other, like a south pole. The lines of force emerge out of the north pole of a magnet and enter in the south pole as shown in the figure. The polarity of a current carrying solenoid can be determined by the following rule.



Hold the solenoid in your right hand by curling the fingers in the direction of the current; the stretched thumb would indicate towards the north pole.

The poles of a solenoid can also be found out by the following easy rule.

Hold down the end of the current carrying solenoid in front of you, if the direction of current flow through this end is anticlockwise, it would be north pole, otherwise it would be a south pole.

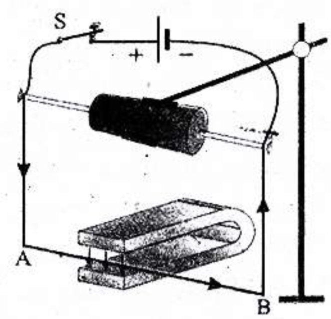
Q. Describe an experiment to show that when a straight current carrying conductor is placed in a magnetic field, it experiences a force. Also state the rule by which the direction of this force can be determined.

Ans. **Force on a current carrying conductor in a magnetic field:**

When a current carrying conductor is placed in a magnetic field at right angles to it, it experiences a force as demonstrated by the following experiment.

Experiment:

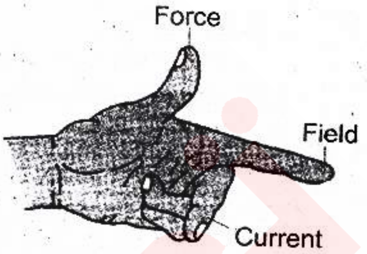
Fix two iron nails into the opposite faces of a large size cork. The nails should be in line with each other and should not touch inside the cork. Clamp the cork on a stand so that the nails are horizontal. Now take a thick wire and bend it in the shape of U. Make hooks at its two ends. With the help of these hooks, suspend the U shape wire from the two nails so that the horizontal part of the wire passes through the space between the pole pieces of a horse shoe magnet.



Connect the two nails with a battery and a switch. As the key is pressed, current starts flowing through the U shaped wire and simultaneously the wire moves inwards. This movement of the wire is due to the force which is acting on the side AB of wire. If the direction of current is reversed the wire moves outwards.

Direction of force:

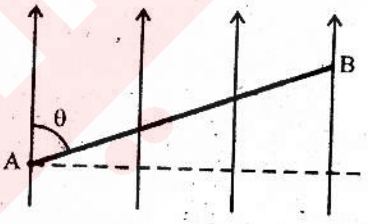
The direction of force acting on the side AB of a current carrying conductor can be determined by Fleming's left hand rule.



"According to this rule, stretch the thumb, forefinger and the middle finger of the left hand mutually at right angles to each other. If the forefinger points in the direction of magnetic field, the middle finger in the direction of the current, then the thumb would indicate the direction of the force acting on the conductor."

Force on conductor if current carrying conductor makes an angle with magnetic field:

If instead of 90^{o} the current carrying conductor makes an angle θ with the magnetic field and the force acting upon the conductor in such a case is directly proportional to sin θ. As such the force acting upon the conductor is maximum only when it is placed at right angles to the field. If the conductor is placed parallel to the field, no force would act upon the conductor because the value of sinθ is zero.



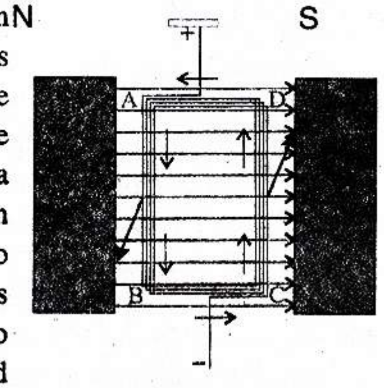
Q. How current carrying coil rotates in a magnetic field?

Ans. When a current carrying rectangular coil is placed in magnetic field then it rotates about its axis.

EXPLANATION:

The movement of coil inside the magnetic field can be explained with the help of experiment.

A rectangular coil ABCD has been placed in between the pole pieces of a magnet in such a way that it can be freely rotate about its axis in the space between the poles. The initial position of the coil is shown in figure. In this position, the side AB and CD of the coil is perpendicular to the field, where as side BC and DA are parallel. Now if the ends of the coil are connected to the positive and negative terminals of a battery, a current would start flowing through the coil as shown in fig. The direction of the current in the side BC and DA is parallel to the magnetic field, so no force would act on these sides. In sides AB and CD, the direction of current is at right angles to the field, so force would act on these sides. According to Fleming's left hand rule, the forces acting on these perpendicular sides would act horizontally in the opposite directions. The magnitude of these forces would be equal. Under the action of these two equal but opposite forces a couple would act on the coil due to which it would start rotating.



Q. Write a note on D.C. Motor.

Ans. D. C. MOTOR

D. C. Motor converts the electrical energy of battery into mechanical energy, which is utilized for different types of work.

CONSTRUCTION

D. C. Motor consists of following parts:

1- Rectangular coil which is mounted on spindle.
2- Permanent magnet.
3- Copper split ring which is split into two halves S_1 and S_2.
4- Two carbon brushes X and Y

D. C. Motor consists of a rectangular coil **abcd** mounted on spindle so that it can rotate between the poles of a permanent magnet.

The position of different sides of rectangular coil is given below:

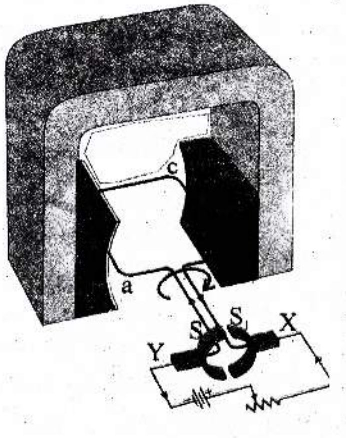
1- Side ab is perpendicular to magnetic field.
2- Side dc is perpendicular to magnetic field.
3- Side ad is parallel to magnetic field.
4- Side bc is parallel to magnetic field.

When the ends of the coil are connected to battery then current flows through it and coil rotates inside the magnetic field.

As sides ab and dc, the direction of current is at right angles to the field, so force would act on these sides, no force would act on sides ad and bc.

According to Fleming's left hand rule, the forces are acting on these perpendicular sides. A copper ring is fixed on the spindle of the coil. This ring is split into two halves S_1 and S_2. One end of the coil is soldered with the split ring S_1 and the other to split ring S_2. Two carbon brushes X, Y are caused to press lightly against the rings by means of springs.

WORKING:



When the brushes are connected to the battery, the coil starts rotating.

Suppose when the current is switched on, the coil is in horizontal position. In this position, the split ring S_1 is in contact with brush X and split ring S_2 is in contact with brush Y. The current flows through the different sides of the coil. According to Fleming's left hand rule, the force acting on side AB is directed upward and that on side CD is directed downwards. Under the action of these two equal but opposite forces, a couple acts upon the coil, which causes it to rotate in the clockwise direction.

When coil reaches in the vertical position the brushes reach to vacant space between the split rings and their connection with the coil is cut off, the coil instead of becoming stationary, it continues to move beyond this vertical position because of its momentum and the connection of split ring with brushes is again established. This time brush X is in contact with split ring S_2 and brush Y is in contact with split ring S_1. Now the direction of current flow in the coil is reversed. Side AB experienced a downward force and side CD experienced a upward force thus coil continues to rotate in clock wise direction.

Q. Explain the electromagnetic induction and also state Faraday's Law.

Ans. ELECTROMAGNETIC INDUCTION

When there is a relative motion between magnet and coil, then e.m.f is induced in the coil. The magnitude of this induced e.m.f depends upon the speed of relative motion. This phenomenon is called electromagnetic induction.

EXPLANATION

Take a solenoid and connect a galvanometer with its two ends.

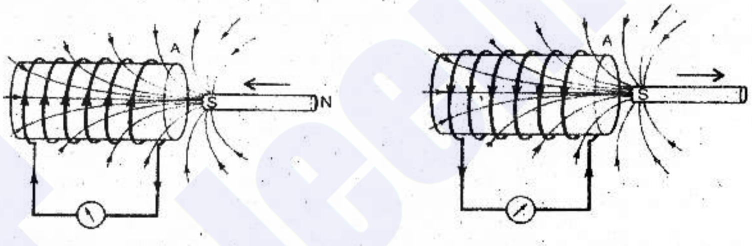
1- If the north pole of a bar magnet is quickly moved towards the end A of the solenoid, the needle of galvanometer gets deflected which shows that an e.m.f has been generated in the solenoid.

2- If we stop the motion of the magnet then there is no deflection in the galvanometer, it means no e.m.f is generated in the coil.

3- If the north pole of the magnet is moved away from the end A, again the galvanometer shows a deflection but this time, in opposite direction.

4- When the south pole of the magnet is brought close to end A of the solenoid and induced current flows through the galvanometer and the direction of the current is opposite to the current induced in case of north pole.

5- Similar results will be obtained if the magnet is kept stationary and the solenoid is moved towards or away from the magnet.



Faraday's law

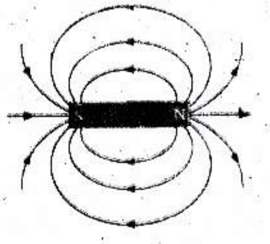
Micheal Faraday stated this law in 1831. According to this law:

"The value of the induced emf is directly proportional to the rate of change of flux." This is known as Faraday's Law of Electromagnetic Induction.

Q. What do you mean by magnetic flux?

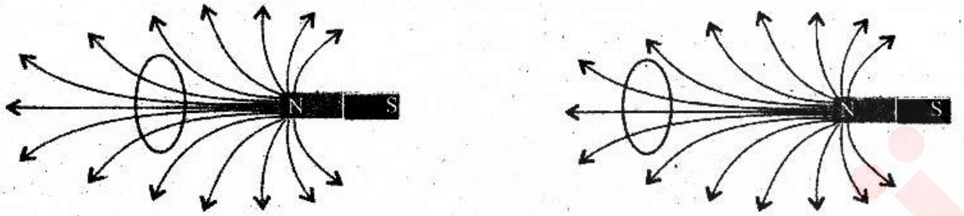
Ans. Definition

The number of magnetic lines of force passing through a certain surface is known as the magnetic flux through that surface.



Explanation

If a coil is placed in the magnetic field of a bar magnet, some of the lines of force will pass through its face. If the coil is far away from the magnet, only a few lines of force will also pass through it. On the other hand, if the coil is close to the magnet, a large number of lines of force will pass through it. The number of magnetic lines of force passing through any surface is known as magnetic flux through that surface.



Q. What is A.C. Generator? Explain its construction and working.

Ans. A.C. generator

It is a device which converts mechanical energy into electrical energy. This energy is in the form of alternating current.

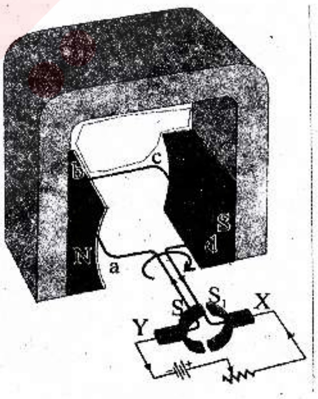
Principle:

When a coil rotates in a magnetic field, the flux passing through it continuously changes. This change of flux induces an e.m.f in the coil.

Construction

It consists of following parts:

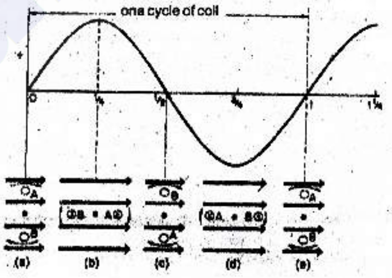
1- Rectangular coil. 2. Permanent magnet
3. Slip rings 4. Two carbon brushes



A simple generator consists of a rectangular coil, which is rotated between the poles of a permanent magnet. Both the ends of the coil are soldered to the two slip rings fixed on the arm of the coil.
Two carbon brushes are kept in contact with these slip rings with the help of two springs. Current is drawn from the coil through these brushes.

Working

1- Suppose in the beginning the coil is vertical with its side A upward and side B downward. The sides A and B are moving parallel to the field due to which the rate of change of flux through the coil is zero, so according to Faraday's Law, the emf induced in the coil is zero.



2- After completing one quarter of the rotation, both the sides A and B are moving at right angles to the field and the rate of change of flux through the coil is maximum. Hence the e.m.f induced at this instant is maximum.

3- After one half rotation of the coil, the position of sides A and B again are moving parallel to the field, so the e.m.f induced is zero. In this position side A is located downward and side B upward.

4- After completing three quarters of its rotation, the e.m.f is at its maximum value but its direction is opposite.

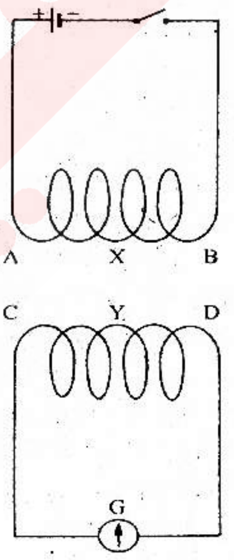
5- After one complete rotation, again the e.m.f is zero. Now, coil starts its next rotation and with it, the next cycle of induced e.m.f also starts. In this way the rotation of the coil in a magnetic field generates an alternating induced e.m.f.

Q. What is meant by mutual induction? Describe an experiment to explain this phenomenon.

Ans. <u>MUTUAL INDUCTION:</u>

Definition:

"If a current is induced in a circuit due to a change of current in another circuit, this phenomenon is known as mutual Induction".



Consider two coils X and Y. X is connected with a battery and a switch, galvanometer is connected with the coil Y. As soon as the switch of the coil X is closed, the galvanometer connected with the coil Y shows a momentary, deflection indicating a momentary flow of current through the coil Y inspite of the fact that the two coils are quite separate having no electrical connection between them.

Similarly at the instant when the flow of current in the coil X is stopped by putting its switch off, the galvanometer connected with the coil Y again shows a deflection but this time its direction is opposite to that of the previous case.

As soon as the switch connected with coil X is closed, a current begins to flow in it and with it, its magnetic field begins to build up. Some of the lines of force of this filed start passing the neighbouring coil Y, which results in the change of magnetic flux to take place through the coil Y due to which a current is induced in its circuit. As soon as magnetic field of coil X attains its constant value, it stops increasing due to which the increase in flux through the coil Y also stops. Hence the induced current reduces to zero. The magnetic field of coil X attains its constant value within a few moments, therefore the current induced in coil Y is also momentary.

Similarly when the switch of the coil X is opened, the flow of current through it stops and in few moments its magnetic field reaches to zero. The flux through the coil Y decreases to zero due to which current is again induced in it. As this current is induced due to the decrease in flux, so its direction is opposite to the direction of the previous momentary current because that current was induced in the coil Y due to increase in the value of magnetic flux.

Q. What is meant by self induction? Describe an experiment to show the voltage generated by self induction.

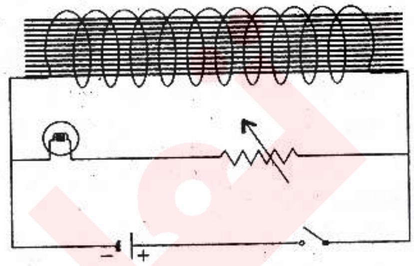
Ans. <u>SELF INDUCTION:</u> (L. B 10)

"If a current through a coil or circuit changes and this change induces an emf in the circuit itself than this phenomenon is called self induction."

We have read that as current passes through a coil, it produces a magnetic field, the lines of force of which pass through the different turns of the coil. If the current passing through the coil changes, then the magnetic field produced by it also changes which results in a change in the number of lines of force passing through the coil. In other words, the magnetic flux linked with the coil changes. This causes an induced emf in the coil.

EXPERIMENT

The phenomenon of the self induction can be demonstrated by an experiment. If the bulb and battery are connected parallel to coil and when the switch is put on, the bulb does not light up because the battery voltage is not sufficient for this purpose. If the switch is put off, the lamp flashes for a few moments indicating that a voltage is higher than that of the battery.

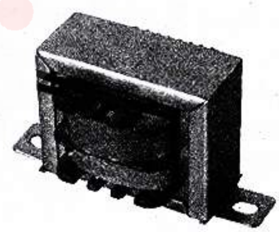


It has been instantaneously supplied by the coil to the bulb due to which the bulb flashes. This large voltage is the self induced voltage produced in the coil at the instant when the switch is put off.

Q. What is transformer? Explain its construction and working.

Ans. Transformer

"Transformer is an electrical device which is used to increase or decrease the value of the alternating voltage".



Construction

It consists of two coils which are wound on two different sides of a rectangular iron core. One coil is called primary coil and the second one is known as secondary coil.

Working

The alternating voltage whose value is to be altered, is supplied to the primary due to which an alternating current begins to flow through it. This current creates a continuously changing magnetic flux through the primary coil. The flux generated by the primary coil is also linked up with the secondary. The iron core enhances the magnetic flux to a very large value and also concentrates it into the core with result that the whole of flux generated by the primary coil is linked up with the secondary. As this flux is continuously changing, therefore, in accordance with the principle of mutual induction, an alternating voltage is induced across the second coil. The value of this voltage depends upon the numbers of turns in the primary and secondary coils.

Mathematical form

Suppose:

N_p = number of turns in the primary coil.

N_s = number of turns in the secondary coil.

E_p = voltage applied across the primary coil which is to be altered.

E_s = The required voltage generated across the secondary coil.

Then we can prove that:

$$\frac{E_s}{E_p} = \frac{N_s}{N_p}$$

Primary Coil:

The coil in which the change in current produces induced current in another coil is known as primary coil.

Secondary Coil:

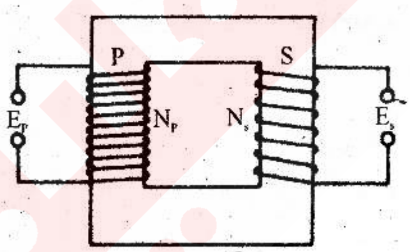
The second coil in which current is induced is known as secondary coil.

Types of transformer

There are two types of transformer:

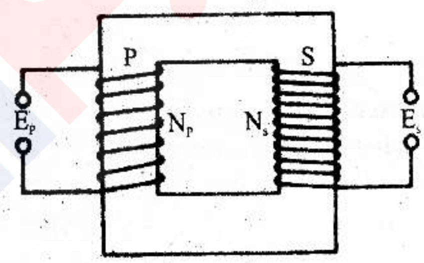
1- Step down transformer
2- Step up transformer

Step down transformer



If the number of turns in the secondary coil are less than the number of turns in the primary (Ns < Np), such a transformer is called step down transformer. It is used to decrease the value of alternating voltage.

Step up transformer



If the number of turns in the secondary coil are greater as compared to number of turns in the primary (Ns > Np), such a transformer is known as step up transformer. It is used to increase the value of alternating voltage.

EXERCISE

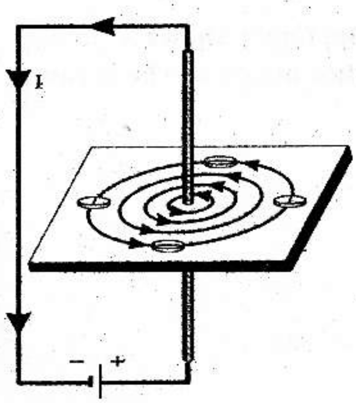
Q1. Draw the magnetic lines of force in the following cases:

a. Straight current carrying conductor

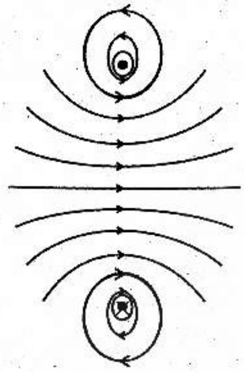
b. Current carrying coil

c. Current carrying solenoid

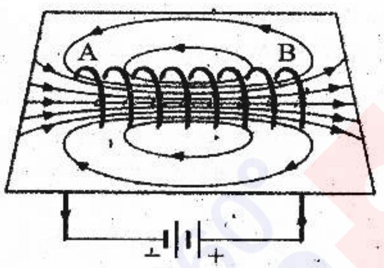
Ans. a. Straight current carrying conductor



b. Current carrying coil

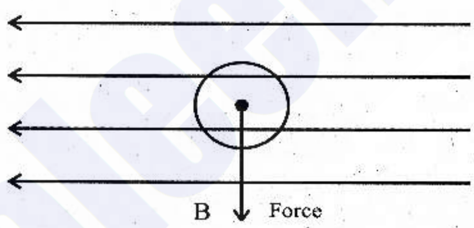


c. Current carrying solenoid

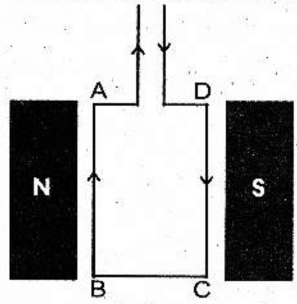


Q2. **The figure shows the cross section of a straight current carrying wire. The arrows represent the magnetic field in which the wire has been placed. Indicate the force acting on the wire by an arrow sign.**

Ans.



Q.3: **The figure shows a current carrying coil suspended in between the pole of pieces of a horse shoe magnet. The arrow indicates the direction of the**



Current flow through the coil. Explain whether the coil would rotate in the clock-wise or anticlockwise direction.

Ans. According to Fleming's rule in the figure on side CD the force will act down direction and on side AB force will act in upward direction so a couple will act on a coil, and the coil will rotate in clockwise direction.

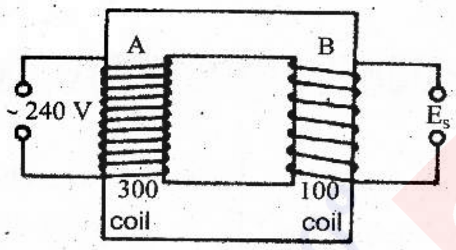
NUMERICALS

17.14 A transformer has been shown in figure. Which of its coil is primary and which one is secondary? What would be the value of the output voltage?

What type of transformer is this?

Coil 'A' is coil primary

Coil 'B' is coil secondary



Sol:

Primary Voltage = E_p = 240v

Number of turns in primary coil = N_p = 300 Turns

Number of turns in secondary coil = N_s = 100 Turns

Secondary Voltage = E_s = ?

We know that

$$\frac{E_s}{E_p} = \frac{N_s}{N_p}$$

$$E_s = \frac{N_s}{N_p} \times E_p$$

Putting the value

$$\frac{E_s}{E_p} = \frac{100}{300}$$

$$E_s = \frac{100 \times 240}{300}$$

$$\boxed{E_s = 80\ V}$$

Since $E_s < E_p$, so it is a step down transformer.

17.15 A step down transformer changes 250 volts A.C into 6 volts A.C. If the number of turns in its primary is 10000, find the number of turn in its secondary.

Sol: E_p = 250 volts

E_s = 6 volts
N_p = 10000
N_s = ?

We know that

$$\frac{E_s}{E_p} = \frac{N_s}{N_p}$$

$$\frac{6}{250} = \frac{N_s}{10000}$$

$$\frac{6 \times 10000}{250} = N_s$$

N_s = 240 turns

MULTIPLE CHOICE QUESTIONS

Q. Circle the correct answer.

1. A transformer has $N_p = 100$ and $N_s = 500$, if 6 volt D.C is applied across its primary, the induced voltage is:

a) 0 V b) 30 V
c) 45 V d) 60 V

2. Iron core is used in transformer to:

a) enhance the flux
b) decrease the flux
c) keep flux the same
d) both a and b

3. Transformer works on the principle of:

a) self induction
b) Mutual induction
c) Electrostatic
d) induction

4. Equation for transformer is:

a) $\frac{N_S}{E_P} = \frac{E_P}{N_S}$ b) $\frac{N_S}{N_P} = \frac{E_P}{E_S}$
c) $\frac{N_S}{N_P} = \frac{E_S}{E_P}$ d) $\frac{N_S}{N_P} = \frac{E_P}{N_P}$

5. The number of lines of force in a magnetic field depends upon:

a) shape of coil b) size of coil
c) Magnet d) Strength of field

6. If current is flowing from bottom end to the top end in a wire, according to right hand rule the direction of line of forces would be:

a) Anti-clock wise
b) Clock wise
c) Left to right
d) along the conductor

7. The lines will be in the form of concentric circles, if conductor is:

a) Circular b) straight
c) Solenoid d) None of these

8. Cross shows the direction of current is _______ in the coil:

a) top to bottom b) into the paper
c) out of paper d) both a,b

9. Dot shows the direction of current is _______ in the coil:

a) top to bottom b) bottom to top
c) into paper d) out of the paper

10. The end of solenoid from which lines of force emerge is called:
a) North pole b) south pole
c) North and south pole
d) none

11. The end of solenoid from which line of forces enter is called:
a) North pole b) South pole
c) North and south pole
d) none

12. The magnetic field of a solenoid resembles as:
a) Iron wire b) U-shape magnet
c) Bar magnet d) Point charge

13. A current carrying conductor produces a field around it is called
(Lahore Board 2006)
a) electric field b) Magnetic field
c) both a and b d) none

14. According to Fleming's left hand rule the direction of magnetic field is indicated by:
a) thumb b) forefinger
c) Middle finger d) right hand rule

15. According to Fleming's left hand rule the direction of force on the conductor is given by:
a) Thumb b) Fore finger
c) Middle finger d) none

16. The force on a current carrying conductor is maximum if angle between field and conductor is:
a) 0° b) 90°
c) 180° d) 45°

17. The force on a current carrying conductor will be minimum if angle between conductor and filed is:
a) 0° b) 70°
c) 45° d) 60°

18. In D.C. motor split rings are made of:
a) Steel b) carbon
c) Copper d) iron

19. Who discovered electromagnetic induction?
a) Micheal Faraday
b) Fleming
c) Ohm d) Coulomb

20. When did Micheal Faraday discover electromagnetic induction?
a) 1841 b) 1831
c) 1821 d) 1811

21. Which type of energy is converted into mechanical energy in the D.C. motor?
a) Magnetic energy
b) Heat energy
c) Electrical energy
d) Chemical energy

22. Which device has two coils, primary and secondary?
a) D.C Motor b) Transformer
c) A.C. generator
d) a and b

23. The voltage is decreased by:
a) Step up transformer
b) Step down transformer
c) A.C. generatord) D.C. Motor

24. Transformer which increases voltage is called:
a) Step up transformer
b) Step down transformer
c) D.C. Motor d) A.C. Generator

25. In A.C generator flux will be zero if coil is: *(Lahore Board 2005)*

a) 90^o b) 45^o

c) parallel d) inclined

26. If the change of current in a circuit induces a current in another circuit, this phenomena is known as

a) Self induction

b) Mutual induction

c) Electromagnetic induction

d) Non-mutual induction

27. The shape of magnetic lines of force in case of a straight current carrying conductor is:

a) elliptical b) triangular

c) rectangular d) circular

28. When a current carrying conductor is placed in magnetic field at right angles to it. The direction of force acting upon it is:

a) the same as direction of field

b) opposite to the direction of the field

c) makes an, angle of 45^o with the current

d) at right angle to both the field and the current.

ANSWERS

1.	a	**2.**	a	**3.**	b	**4.**	c	**5.**	d	**6.**	a	**7.**	b
8.	b	**9.**	d	**10.**	a	**11.**	b	**12.**	c	**13.**	b	**14.**	b
15.	a	**16.**	b	**17.**	a	**18.**	c	**19.**	a	**20.**	b	**21.**	c
22.	b	**23.**	b	**24.**	a	**25.**	c	**26.**	b	**27.**	d	**28.**	d

SHORT ANSWERS

Q.1: What do you understand by magnetic flux?

Ans. The number of magnetic lines of force passing through any surface is known as magnetic flux.

Q.2: On what factors the magnitude of induced e.m.f depends?

Ans. The magnitude of induced e.m.f. depends upon the relative speed of magnet and the coil. Higher the speed, larger the induced e.m.f. It also depends upon the following factors:

1- Strength of the field.

2. Number of turns in the coil.

Q.3: What is an A.C. generator? Write its principle.

Ans. A.C. generator converts mechanical energy into electrical energy i.e. it produces alternating voltage. The principle on which it works is electromagnetic induction. i.e. when a coil rotates in a magnetic field the flux passing through it continuously changes. This change of magnetic flux produces an induced e.m.f.

Q.4: What is mutual induction? (L. B '09)

Ans. If a current is induced in a circuit due to change of current in another circuit. This phenomenon is known as mutual induction.

Q.5: What is a transformer? On which principle it works? (L. B '08, 09)

Ans. A transformer, is an electrical device which is used to increase or decrease the value of alternating voltage. It cannot increase or decrease D.C. voltage. It works on the principle of mutual induction.

Q.6: What are two types of transformer and how they are made?

Ans. The two types of transformer are step up transformer and step down transformer.

If number of turns in the secondary coil is more than the number. of turns in the primary coil, then it is step-up transformer. Conversely if number of turns primary are more than the number of turns in the secondary then it is step down transformer.

Q.7: What is meant by primary and secondary coils?

Ans. The coil in which the change in current produces induced current in another coil is known as primary coil and the coil in which current is induced is called secondary coil.

Q.8: What is the function of split rings in D.C. motor?

Ans. Split rings connect the coil to the battery through carbon brushes. When coil rotates in between the pole pieces of a magnet, split rings keep the current in the coil in the same direction and hence coil rotates in the same direction.

Q.9: What is a D.C. motor? On which principle it works?

Ans. D.C. Motor is a device which converts electrical energy into mechanical energy. It works on the principle that when current passes through a coil placed in magnetic field, it experiences a force due to which coil rotates in the field.

Q.10: State Fleming's left hand rule.

Ans. The direction of force on a current carrying conductor is given by Fleming's Left Hand Rule, it states as "stretch the thumb, fore finger and the middle finger of the left hand mutually at right angles to each other. If the fore finger points in the direction of the magnetic field, the middle finger in the direction of current, then thumb will indicate the direction of force on the conductor.

Q.11: State the rule to find north and south poles of a current carrying solenoid. (L. B '10)

Ans. Hold the solenoid in your right hand by curling the fingers in the direction of current. The stretched thumb will indicate the north pole OR

Hold down the end of current carrying solenoid in front of you, if the direction of flow of current to this end is anti-clockwise, it will be the north pole, otherwise it would be a south pole.

Q.12: State right hand rule to find direction of magnetic field in a current, carrying straight wire.

Ans. It states hold the current carrying straight conductor in right hand in such a way that thumb shows the direction of current then curling of right hand fingers will give the direction of magnetic field, which will be in the form of concentric circles.

Q.13: What is a solenoid. And what type of magnetic field it possesses?

Ans. A solenoid is a closely wound cylindrical coil of insulated wire. The magnetic field pattern of solenoid is just like the magnetic filed resembling to the bar magnet.

Q.14. What do the cross and dot mean in current carrying coil?

Ans. The cross (x) means the current is flowing into the plane of paper whereas dot(.) means current is flowing out of the plane of paper.

Q.15. When is the force on a current carrying conductor in a magnetic field maximum and when it is minimum?

Ans. When a current carrying conductor makes an angle of 90° with the magnetic field i.e. when it is perpendicular to the field, the force will be maximum.

If the conductor is placed along or parallel to the magnetic field, no force acts on the conductor.