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Q) Write Shorts Notes:

Time Period:

- Time period is the time it takes for one complete cycle of a wave to pass. It is measured in second
  .

Amplitude:

- Amplitude is the maximum displacement of a wave from its rest position. It is measured in units like metres or centimetres.

Waveform

- Waveform is the shape of a wave. It is the pattern of displacement that the wave makes as it propagates through space.

Frequency:

- Frequency is the number of cycles of an oscillating wave per unit time. In AC circuits, frequency is measured in hertz (Hz). A higher frequency indicates a faster oscillation and a shorter wavelength.

Impedance:

- Impedance is the total opposition to the flow of electric current in an AC circuit. It is measured in ohms (Ω). Impedance is a complex quantity, combining resistance and reactance.

Phase Angle:

- Phase angle is the angle between the voltage and current phasors in an AC circuit. It represents the time difference between the zero crossings of the voltage and current waveforms.

Average Value:

- Average value, also known as mean value, is the arithmetic mean of the values of a waveform over one cycle. For a sinusoidal waveform, the average value is zero.

Reactance:

- Reactance is the imaginary part of impedance, representing the opposition to current flow due to inductive or capacitive elements. It is measured in ohms (Ω). Inductive reactance is denoted by X_L, while capacitive reactance is denoted by X_C.

Active Power:

- Active power, also known as real power, is the rate at which energy is transferred from the source to the load in an AC circuit. It is measured in watts (W).

RMS Value:

- RMS value, also known as root mean square value, is the square root of the mean of the squared values of a waveform over one cycle. For a sinusoidal waveform, the RMS value is 0.707 times the peak value.

Power Factor:

- Power factor is the ratio of active power to apparent power in an AC circuit. It is a dimensionless quantity ranging from 0 to 1. A higher power factor indicates a more efficient transfer of energy.

Reactive Power:

- Reactive power is the imaginary part of complex power, representing the energy stored and released by inductive and capacitive elements. It is measured in volt-ampere reactive (VAR).

Form Factor:

- Form factor is the ratio of the RMS value to the average value of a waveform. For a sinusoidal waveform, the form factor is 1.11.

Angular Factor:

- Angular factor, also known as phase displacement factor, is the cosine of the phase angle between voltage and current in an AC circuit. It represents the portion of the apparent power that is active power.

Apparent Power:

- Apparent power is the product of RMS voltage and RMS current in an AC circuit. It is measured in volt-ampere (VA).

Crest Factor:

- Crest factor is the ratio of the peak value to the RMS value of a waveform. For a sinusoidal waveform, the crest factor is 1.41.

Cycle:

- A cycle is one complete oscillation of a waveform. For a sinusoidal waveform, a cycle consists of a positive half cycle and a negative half cycle.

Efficiency of Transformers:

- Transformer efficiency is the ratio of output power to input power. It is typically between 90% and 99%. Transformer efficiency is affected by various factors, including core losses, copper losses, and stray losses.

Transformers:

Transformers are passive electrical components that transfer electrical energy from one circuit to another without any direct physical contact between the two circuits. They are based on the principle of electromagnetic induction, which states that a changing magnetic field can induce an electric current in a nearby conductor.

Transformers are used in a wide variety of applications, including:

- Stepping up or stepping down voltage
- Isolating circuits from each other

- Matching impedance between circuits
- Providing a path for AC signals while blocking DC signals

Types of Transformers:

There are many different types of transformers, but they can be broadly classified into two main categories:

- **Power transformers:** These transformers are designed to transfer large amounts of electrical power. They are commonly used in power distribution systems to step up or step down voltage.
- **Signal transformers:** These transformers are designed to transfer electrical signals. They are commonly used in electronic circuits to isolate circuits from each other or to match impedance between circuits.

The basic working principle of a transformer is as follows:

- **Primary winding:** An AC voltage is applied to the primary winding of the transformer. This creates a changing magnetic field in the transformer core.

- **Secondary winding:** The changing magnetic field induces an AC voltage in the secondary winding of the transformer. The voltage induced in the secondary winding is proportional to the voltage applied to the primary winding and the turns ratio of the transformer.

- **Turns ratio:** The turns ratio of a transformer is the ratio of the number of turns in the secondary winding to the number of turns in the primary winding. A transformer with a turns ratio of greater than 1 is a step-up transformer, while a transformer with a turns ratio of less than 1 is a step-down transformer.

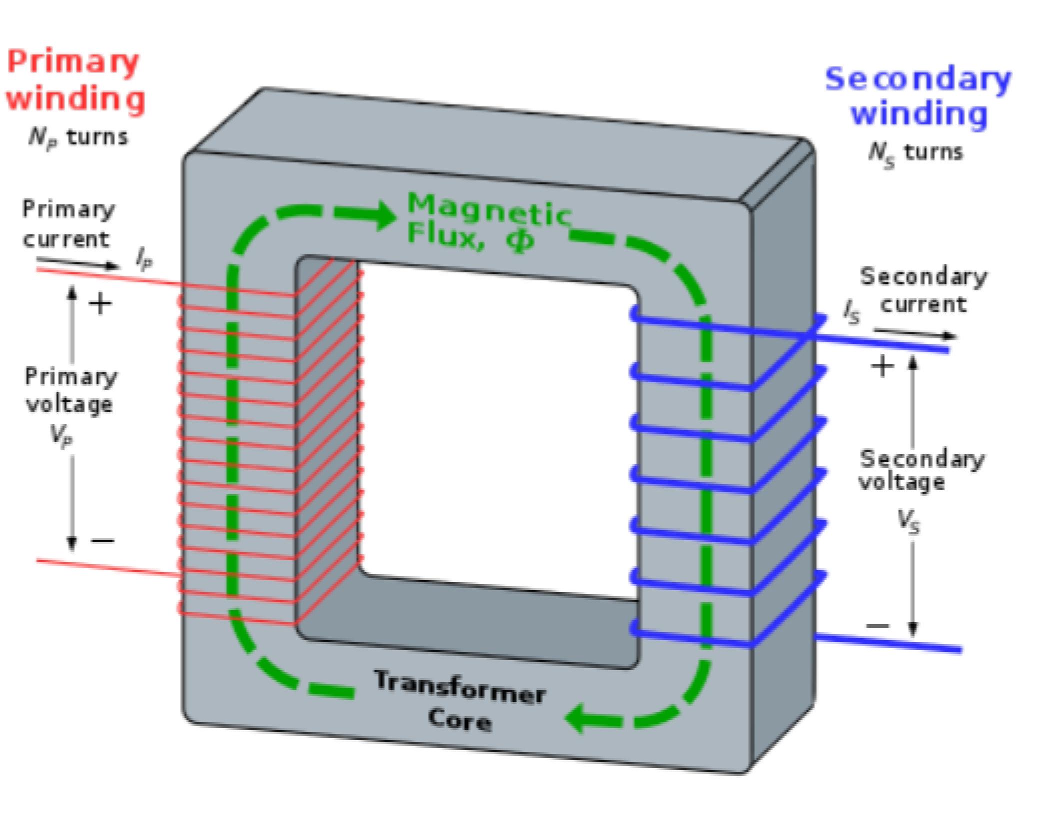
Need for Transformers:

Transformers are essential components in modern electrical systems. They are used in a wide variety of applications because they offer several advantages over other methods of transferring electrical energy, such as:

- **High efficiency:** Transformers are highly efficient devices, with efficiencies typically between 90% and 99%.
- **Isolation**: Transformers can provide electrical isolation between circuits. This is important for safety reasons and can also be used to improve the performance of electronic circuits.
- **Voltage matching:** Transformers can be used to step up or step down voltage to the desired level. This is essential for many applications, such as power distribution and electronic circuit design.

Transformers perform a number of important functions in electrical systems, including:

- **Voltage transformation:** Transformers are used to step up or step down voltage to the desired level.
- **Current isolation:** Transformers can provide electrical isolation between circuits.
- **Impedance matching:** Transformers can be used to match impedance between circuits.
- **Signal filtering:** Transformers can be used to filter out unwanted frequencies from electrical signals.
- **Power distribution:** Transformers are used in power distribution systems to step up or step down voltage.



DC Motor:

Definition:

A DC motor, or direct current motor, is an electrical machine that converts direct current electrical energy into mechanical energy. It operates based on the principles of electromagnetism and the Lorentz force, where the interaction between a magnetic field and an electric current generates rotational motion.

Working Principle:

The basic working principle of a DC motor involves the interaction between magnetic fields and electric currents. Here's a simplified explanation:

- **Lorentz Force:** When a current-carrying conductor is placed in a magnetic field, a force is exerted on the conductor. This force is known as the Lorentz force and is perpendicular to both the direction of the current and the magnetic field.

- **Armature and Magnetic Field**: A DC motor consists of an armature (a coil of wire) and a stator (a stationary magnetic field). The armature is connected to a DC power source. When current flows through the armature, a magnetic field is produced around it.

- **Rotor Rotation:** The magnetic field of the armature interacts with the stationary magnetic field of the stator. The Lorentz force causes the armature to experience a torque, resulting in the rotation of the rotor (the moving part of the motor).

- **Commutator and Brushes:** To maintain continuous rotation, a commutator (a rotary switch) is used to reverse the direction of the current in the armature coil as it rotates. Brushes are in contact with the commutator, ensuring the flow of current in the right direction to sustain rotation.

DC Brush Motors:

Separately Excited DC Motor:

- The field winding is supplied by an independent source.

Shunt DC Motor:

- The field winding is connected in parallel with the armature.

Series DC Motor:

- The field winding is connected in series with the armature.

Brushless DC Motors (BLDC):

- Also known as electronically commutated motors, these motors use electronic controllers instead of a mechanical commutator to control the direction of current flow in the windings.

Permanent Magnet DC Motors:

- These motors use permanent magnets to create the magnetic field, eliminating the need for a separate field winding.

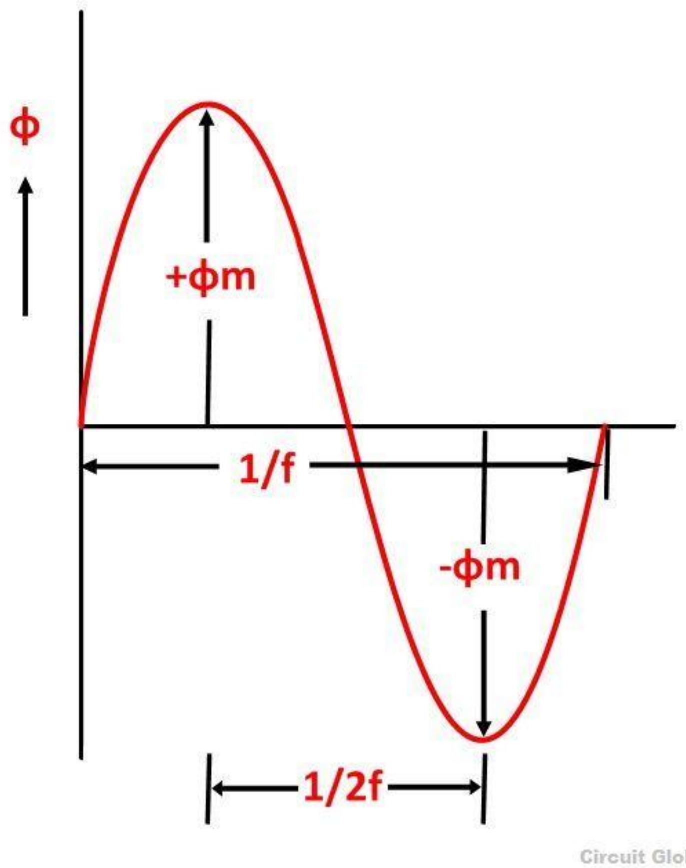
DC motors are widely used in various applications, such as electric vehicles, robotics, conveyor systems, and household appliances, due to their simplicity, reliability, and ease of speed control.

Derivation of EMF equation for Transformers:

The electromotive force (EMF) induced in a transformer is derived from Faraday's law of electromagnetic induction. The equation for the induced EMF in a transformer is given by:

- $_m$ be the maximum value of flux in Weber
- f be the supply frequency in Hz
- N_1 is the number of turns in the primary winding
- N_2 is the number of turns in the secondary winding

Φ is the flux per turn in Weber



As shown in the above figure that the flux changes from + ϕ_m to – ϕ_m in half a cycle of 1/2f seconds.

By Faraday's Law

Let E_1 be the emf induced in the primary winding

$$E_1 = -\frac{d\psi}{dt} \dots \dots \dots (1)$$

Where $\Psi = N_1\phi$

$$\text{Therefore, } E_1 = -N_1 \frac{d\varphi}{dt} \quad \dots\dots\dots(2)$$

Since ϕ is due to AC supply $\phi = \phi_m$ Sinwt

$$E_1 = -N_1 \frac{d}{dt} (\varphi_m \, \mathrm{Sinwt})$$

$$E_1 = -N_1 w\varphi_m \, \mathrm{Coswt}$$

$$E_1 = N_1 w\varphi_m \, \mathrm{Sin}(wt - \pi/2) \ldots\ldots\ldots (3)$$

So the induced emf lags flux by 90 degrees.

Maximum valve of emf

$$E_1 max = N_1 w\varphi_m \ldots\ldots\ldots (4)$$

But w = 2πf

$$E_1 max = 2\pi f N_1 \varphi_m \ldots\ldots\ldots (5)$$

Root mean square RMS value is

$$E_1 = \frac{E_{1max}}{\sqrt{2}} \ldots\ldots\ldots (6)$$

Putting the value of E_1max in equation (6) we get

$$E_1 = \sqrt{2}\pi f N_1 \varphi_m \ldots\ldots (7)$$

Putting the value of π = 3.14 in the equation (7) we will get the value of E_1 as

$$E_1 = 4.44 f N_1 \varphi_m \ldots\ldots\ldots (8)$$

Similarly

$$E_2 = \sqrt{2}\pi f N_2 \varphi_m$$

Or

$$E_2 = 4.44 f N_2 \varphi_m \ldots\ldots\ldots (9)$$

Now, equating the equation (8) and (9) we get

$$\frac{E_2}{E_1} = \frac{4.44 f N_2 \varphi_m}{4.44 f N_1 \varphi_m}$$

Or

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$$

The above equation is called the **turn ratio** where K is known as the transformation ratio.

The equation (8) and (9) can also be written as shown below using the relation

($\phi_m = B_m \times A_i$) where A_i is the iron area and B_m is the maximum value of flux density.

$$E_1 = 4.44 N_1 f B_m A_i \text{ Volts} \quad \text{and} \quad E_2 = 4.44 N_2 f B_m A_i \text{ Volts}$$

For a sinusoidal wave

$$\frac{\text{R. M. S value}}{\text{Average value}} = \text{Form factor} = 1.11$$

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