Program- B.TECH

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Course- EM-I

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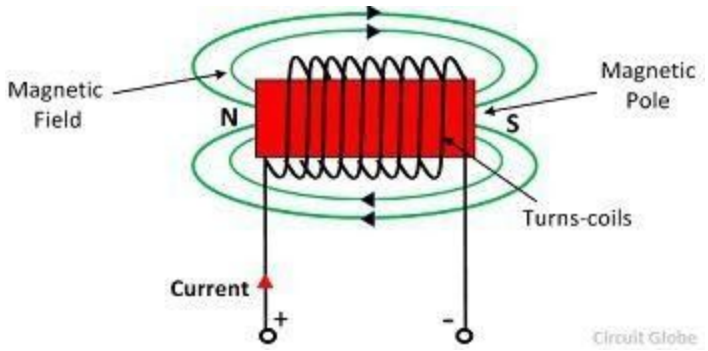
Topic- Magnetic fields and magnetic circuits. (Unit-1)

Magneto motive Force (MMF)-

Definition: The current flowing in an electric circuit is due to the existence of electromotive force similarly magneto motive force (MMF) is required to drive the magnetic flux in the magnetic circuit. The magnetic pressure, which sets up the magnetic flux in a magnetic circuit is called Magneto motive Force. The SI unit of MMF is Ampere-turn (AT), and their CGS unit is G (Gilbert). The MMF for the inductive coil shown in the figure below is expressed as



$$F = NI$$

Where, N – numbers of turns of the inductive coil
I – current

The strength of the MMF is equivalent to the product of the current around the turns and the number of turns of the coil. As per work law, the MMF is defined as the work done in moving the unit magnetic pole (1weber) once around the magnetic circuit.

The MMF is also known as the magnetic potential. It is the property of a material to give rise to the magnetic field. The magneto motive force is the product of the magnetic flux and the magnetic reluctance. The reluctance is the opposition offers by the magnetic field to set up the magnetic flux on it. The MMF regarding reluctance and magnetic flux is given as

$$F = \emptyset R$$

Where R – reluctance
Φ – magnetic flux

The magneto motive force can measure regarding magnetic field intensity and the length of the substance. The magnetic field strength is the force act on the unit pole placed on the magnetic field. MMF regarding field intensity is expressed as

$$F = Hl$$

Where H is the magnetic field strength and l is the length of the substance.

Definition of Magnetic Field

The magnetic field is defined as the region around the magnet where its poles and the electrical charges experience the force of attraction or repulsion. The presence of the field is determined through the needle. In actual practice, the magnetic field has no real existence, and they are purely imaginary. The magnetic field is created because of the magnetic line of force which possesses the following properties.

1. The magnetic line of force forms the closed loop.
2. The direction of magnetic line force is from north to south. But insides the magnetic line of force their direction is from south to north.
3. The magnetic lines never intersect each other.
4. The magnetic lines repel each other when they are parallel and in the same direction.
5. They are not affected by the non-magnetic materials.

Definition of Magnetic Flux

The magnetic flux is defined as the total number of magnetic lines of force produces by the magnet. It is measured in Weber. The one Weber is equal to the 10^8 line of forces or the Maxwell. The Maxwell is the CGS unit of magnetic flux. The magnetic flux is similar to the electric current.

Differences between Magnetic Field and Magnetic Flux

The following are the key differences between the magnetic field and magnetic flux.

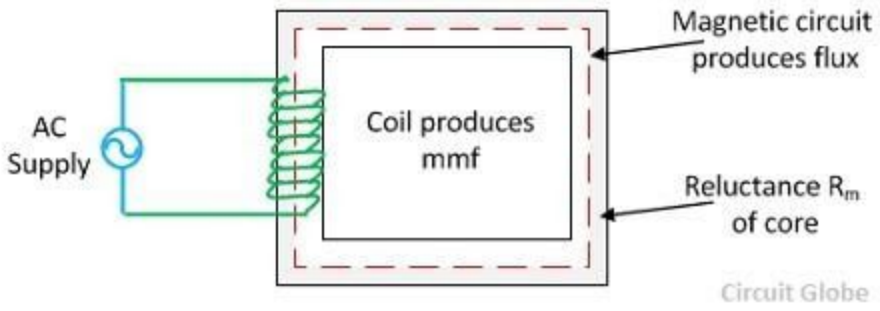
1. The area around the magnetic field where the poles and the moving charge experience the force of attraction and repulsion is called a magnetic field. Whereas, the magnetic flux shows the quantities of the magnetic lines of force passes through it.
2. The magnetic field is expressed as the product of the magnetic strength and the direction of the moving charges. Whereas, the magnetic field is the product of the field strength and the area around the poles.
3. The SI unit of the magnetic field is Telsa whereas the SI unit of magnetic flux is Weber.
4. The magnetic field only depends on the magnet which generates it whereas the magnetic flux depends on the magnetic strength and area.

Basis For Comparison	**Magnetic Field**	**Magnetic Flux**
Definition	The region around the magnet where its poles shows the force of attraction or repulsion.	It shows the quantity of the magnetic line of forces produced by the magnet.
Formula	$F = qvB$	$\emptyset = BA$
SI Unit	Tesla	Weber
Dependence	Only on Magnet that produces it.	On magnet field strength and also the area between them.

Magnetic flux Reluctance

Definition: The obstruction offered by a magnetic circuit to the magnetic flux is known as reluctance. As in electric circuit, there is resistance similarly in the magnetic circuit, there is reluctance, but resistance in an electrical circuit dissipates the electric energy and the reluctance in magnetic circuit stores the magnetic energy.

Also in an electric circuit, the electric field provides the least resistance path to the electric current. Similarly, the magnetic field causes the least reluctance path for the magnetic flux. It is denoted by S.



$$Reluctance\ (S) = \frac{l}{\mu_0 \mu_r A}$$

Where, l – the length of the conductor
μ_o – permeability of vacuum which is equal to 4π X10_7 Henry/metre.
μ_r – relative permeability of the material.
A – cross-section area of the conductor.

Its SI unit is **AT / Wb (ampere-turns / Weber).** The reluctance of the magnetic circuit is directly proportional to the length of the conductor and inversely proportional to the cross-section area of the conductor.

The reciprocal of the magnetic reluctance is known as the magnetic permeance**.** It is given by the expression

$$Permeance\ (P) = \frac{1}{Reluctance} = \frac{1}{R}$$

The reluctance in the DC field is defined as the ratio of the magnetic motive force and to the magnetic flux of the same circuit. The reluctance in the DC field is expressed as

$$Reluctance\ (S) = \frac{m.m.f}{flux} = \frac{F}{\emptyset}$$

Where, S – reluctance in ampere-turns per weber.
F – magnetic motive force
Φ – magnetic flux

The non-uniform magnetic circuit is made by adding the uniform sections having the different value of a length, cross-section area, and permeability of the magnetic circuit.

The reluctance of the non-uniform circuit is calculated by adding the reluctance of the uniform section of the magnetic circuit. The calculation of the non-uniform magnetic field is more complex as compared to the uniform magnetic field.

In most of the transformer, an air gap is created for reducing the effects of the saturation. The air gap increases the reluctance of the circuit and hence stores more magnetic energy before the saturation.

Inductance

Inductance is defined as the ratio of the induced voltage to the rate of change of current causing it. In the SI system, the unit of inductance is the Henry (H), which is the amount of inductance that causes a voltage of one volt, when the current is changing at a rate of one ampere per second.

Inductance is the name given to the property of a component that opposes the change of current flowing through it and even a straight piece of wire will have some inductance. Inductors do this by generating a self-induced emf within itself as a result of their changing magnetic field.

REFRENCES-

1) **www.circuitglobe.com**

Prepared by- Chetanya Gupta

Department- EEE