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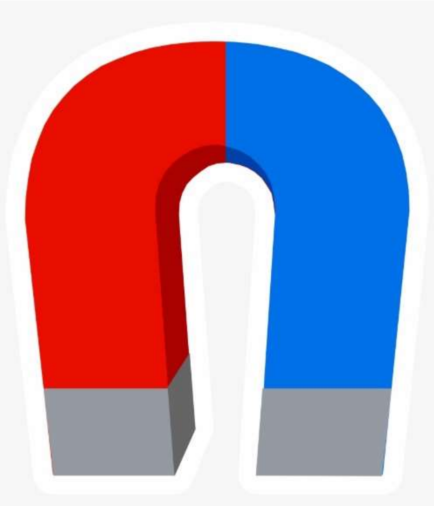
1.0 BRIEF DESCRIPTION

In this project we are getting detailed information about **magnet**, **magnetism** and getting brief information about **magnetic flux**. We're know about magnet is very important metal and it's use in very large quantity in industry. We are also use magnet in our daily routine life. Magnet is metal and it's also have different types like permanent magnet, temporary magnet and electromagnet those are type of magnet. Magnet also have different type of properties like Magnetism and magnetic flux those are types of properties of magnet. This is the little bit information of magnet.

We're use magnet in our daily life devices like mobile phone, speakers, televisions like devices. Magnet is also use in different type of industry like medical industry, manufacturing industry, electronic industry etc. are use different types of magnet in there work. Magnet is metal and it's main property is magnetism, and it's a power of magnet this is a principle thing of magnet and it's working process. In this project we're getting all the information about the **magnet, magnetism** and getting brief information about **magnetic flux**.



2.0 AIM OF MICRO PROJECT

The aim of project is getting all the information of **magnet, magnetism** and **magnetic flux**. Getting all the brief information of the magnets and its use. We're know about magnet is very important thing in our daily life we're all using magnet but we're don't know about magnet and it's properties, how magnet is work and how magnetism is work. What is the properties of magnet we don't know about it. We're don't know about magnetic flux how it's work. How magnet is we're use in our daily life and our daily life use devices but we don't know about it.

Magnet is using by industries like medical, manufacturing, electronic and many more industries. Magnet have different types **like permanent magnet, temporary magnet** and **electromagne**t those are type of magnet but we're don't know about it. Those all things are the aim of this project.

3.0 COURSE OUTCOMES INTEGRATED

A) Learning about Magnetism.

B) Learning about magnet.

C) Learning about Magnetic flux.

D) Learning about magnetism history.

E) Learning about magnets and it’s type.

F) learning about use of magnet .

4.0 OUTPUTS OF MICRO-PROJECTS

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1.0 MAGNETISM

1.1 Introduction :

Magnetism is a class of physical attributes that are mediated by magnetic fields. Electric currents and the magnetic moments of elementary particles give rise to a magnetic field, which acts on other currents and magnetic moments. Magnetism is one aspect of the combined phenomenon of electromagnetism. The most familiar effects occur in ferromagnetic materials, which are strongly attracted by magnetic fields and can be magnetized to become permanent magnets, producing magnetic fields themselves. Demagnetizing a magnet is also possible. Only a few substances are ferromagnetic; the most common ones are iron, cobalt and nickel and their alloys. The rare-earth metals neodymium and samarium are less common examples. The prefix ferro- refers to iron, because permanent magnetism was first observed in lodestone, a form of natural iron ore called magnetite, $Fe3O4$.

All substances exhibit some type of magnetism. Magnetic materials are classified according to their bulk susceptibility. Ferromagnetism is responsible for most of the effects of magnetism encountered in everyday life, but there are actually several types of magnetism. Paramagnetic substances, such as aluminium and oxygen, are weakly attracted to an applied magnetic field; diamagnetic substances, such as copper and carbon, are weakly repelled; while antiferromagnetic materials, such as chromium and spin glasses, have a more complex relationship with a magnetic field. The force of a magnet on paramagnetic, diamagnetic, and antiferromagnetic materials is usually too weak to be felt and can be detected only by laboratory instruments, so in everyday life, these substances are often described as non-magnetic. The magnetic state (or magnetic phase) of a material depends on temperature, pressure, and the applied magnetic field. A material may exhibit more than one form of magnetism as these variables change.

The strength of a magnetic field almost always decreases with distance, though the exact mathematical relationship between strength and distance varies. Different configurations of magnetic moments and electric currents can result in complicated magnetic fields.Only magnetic dipoles have been observed, although some theories predict the existence of magnetic monopoles.

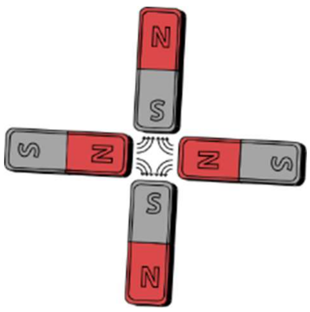

Fig 1.1 A magnetic quadrupole

1.2 History Of Magnetism :

Magnetism was first discovered in the ancient world, when people noticed that lodestones, naturally magnetized pieces of the mineral magnetite, could attract iron. The word magnet comes from the Greek term the Magnesian stone, lodestone. In ancient Greece, Aristotle attributed the first of what could be called a scientific discussion of magnetism to the philosopher Thales of Miletus, who lived from about 625 BC to about 545 BC.[5] The ancient Indian medical text Sushruta Samhita describes using magnetite to remove arrows embedded in a person's body.

In ancient China, the earliest literary reference to magnetism lies in a 4th-century BC book named after its author, Guiguzi. The 2nd-century BC annals, Lüshi Chunqiu, also notes: "The lodestone makes iron approach; some (force) is attracting it." The earliest mention of the attraction of a needle is in a 1st-century work Lunheng (Balanced Inquiries): "A lodestone attracts a needle." The 11th-century Chinese scientist Shen Kuo was the first person to write—in the Dream Pool Essays—of the magnetic needle compass and that it improved the accuracy of navigation by employing the astronomical concept of true north. By the 12th century, the Chinese were known to use the lodestone compass for navigation. They sculpted a directional spoon from lodestone in such a way that the handle of the spoon always pointed south.

Alexander Neckam, by 1187, was the first in Europe to describe the compass and its use for navigation. In 1269, Peter Peregrinus de Maricourt wrote the Epistola de magnete, the first extant treatise describing the properties of magnets. In 1282, the properties of magnets and the dry compasses were discussed by Al-Ashraf Umar II, a Yemeni physicist, astronomer, and geographer.

Leonardo Garzoni's only extant work, the Due trattati sopra la natura, e le qualità della calamita, is the first known example of a modern treatment of magnetic phenomena. Written in years near 1580 and never published, the treatise had a wide diffusion. In particular, Garzoni is referred to as an expert in magnetism by Niccolò Cabeo, whose Philosophia Magnetica (1629) is just a re-adjustment of Garzoni's work. Garzoni's treatise was known also to Giovanni Battista Della Porta.

In 1600, William Gilbert published his De Magnete, Magneticisque Corporibus, et de Magno Magnete Tellure (On the Magnet and Magnetic Bodies, and on the Great Magnet the Earth). In this work he describes many of his experiments with his model earth called the terrella. From his experiments, he concluded that the Earth was itself magnetic and that this was the reason compasses pointed north (previously, some believed that it was the pole star (Polaris) or a large magnetic island on the north pole that attracted the compass).

An understanding of the relationship between electricity and magnetism began in 1819 with work by Hans Christian Ørsted, a professor at the University of Copenhagen, who discovered by the accidental twitching of a compass needle near a wire that an electric current could create a magnetic field. This landmark experiment is known as Ørsted's Experiment. Several other experiments followed, with André-Marie Ampère, who in 1820 discovered that the magnetic field circulating in a closed-path was related to the current flowing through a surface enclosed by the path; Carl Friedrich Gauss; Jean-Baptiste Biot and Félix Savart, both of whom in 1820 came up with the Biot–Savart law giving an equation for the magnetic field from a current-carrying wire; Michael Faraday, who in 1831 found that a time-varying magnetic flux through a loop of wire induced a voltage, and others finding further links between magnetism and electricity. James Clerk Maxwell synthesized and expanded these insights into Maxwell's equations, unifying electricity, magnetism, and optics into the field of electromagnetism. In 1905, Albert Einstein used these laws in motivating his theory of special relativity, requiring that the laws held true in all inertial reference frames.

Electromagnetism has continued to develop into the 21st century, being incorporated into the more fundamental theories of gauge theory, quantum electrodynamics, electroweak theory, and finally the standard model.

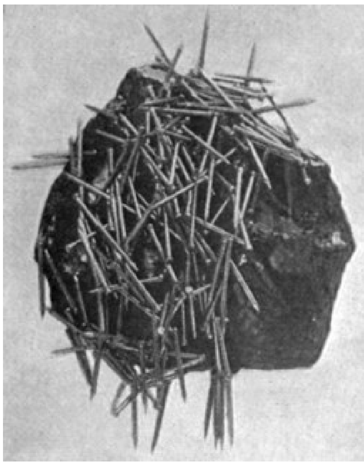

Fig 1.2 Lodestone, a natural magnet

1.3 Type Of Magnetism :

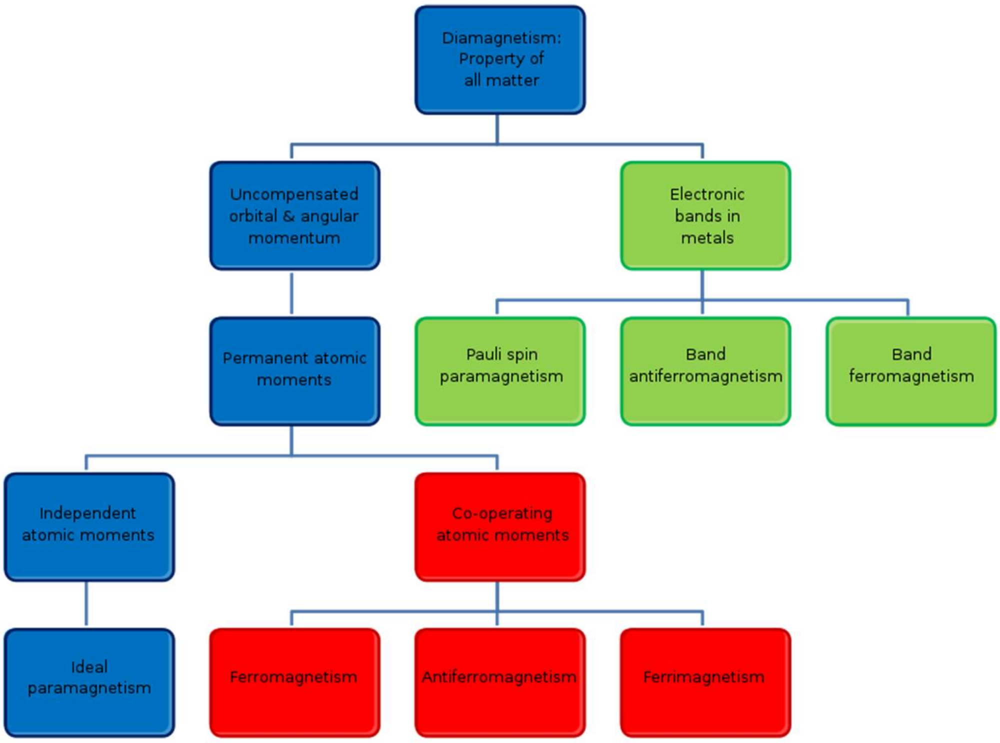

Fig 1.3 Hierarchy of types of magnetism

1.3.1 Diamagnetism :

Diamagnetism appears in all materials and is the tendency of a material to oppose an applied magnetic field, and therefore, to be repelled by a magnetic field. However, in a material with paramagnetic properties (that is, with a tendency to enhance an external magnetic field), the paramagnetic behavior dominates. Thus, despite its universal occurrence, diamagnetic behavior is observed only in a purely diamagnetic material. In a diamagnetic material, there are no unpaired electrons, so the intrinsic electron magnetic moments cannot produce any bulk effect. In these cases, the magnetization arises from the electrons' orbital motions, which can be understood classically as follows:

When a material is put in a magnetic field, the electrons circling the nucleus will experience, in addition to their Coulomb attraction to the nucleus, a Lorentz force from the magnetic field. Depending on which direction the electron is orbiting, this force may increase the centripetal force on the electrons, pulling them in towards the nucleus, or it **may** decrease the force, pulling them away from the nucleus. This effect systematically increases the orbital magnetic moments that were aligned opposite the field and decreases the ones aligned parallel to the field (in accordance with Lenz's law). This results in a small bulk magnetic moment, with an opposite direction to the applied field.

This description is meant only as a heuristic; the Bohr–Van Leeuwen theorem shows that diamagnetism is impossible according to classical physics, and that a proper understanding requires a quantum-mechanical description.

All materials undergo this orbital response. However, in paramagnetic and ferromagnetic substances, the diamagnetic effect is overwhelmed by the much stronger effects caused by the unpaired electrons.

1.3.2 Paramagnetism :

In a paramagnetic material there are unpaired electrons; i.e., atomic or molecular orbitals with exactly one electron in them. While paired electrons are required by the Pauli exclusion principle to have their intrinsic ('spin') magnetic moments pointing in opposite directions, causing their magnetic fields to cancel out, an unpaired electron is free to align its magnetic moment in any direction. When an external magnetic field is applied, these magnetic moments will tend to align themselves in the same direction as the applied field, thus reinforcing it.

1.3.3 Ferromagnetism :

In a paramagnetic material there are unpaired electrons; i.e., atomic or molecular orbitals with exactly one electron in them. While paired electrons are required by the Pauli exclusion principle to have their intrinsic ('spin') magnetic moments pointing in opposite directions, causing their magnetic fields to cancel out, an unpaired electron is free to align its magnetic moment in any direction. When an external magnetic field is applied, these magnetic moments will tend to align themselves in the same direction as the applied field, thus reinforcing it.

1.3.4 Magnetic domains :

The magnetic moments of atoms in a ferromagnetic material cause them to behave something like tiny permanent magnets. They stick together and align themselves into small regions of more or less uniform alignment called magnetic domains or Weiss domains. Magnetic domains can be observed with a magnetic force microscope to reveal magnetic domain boundaries that resemble white lines in the sketch. There are many scientific experiments that can physically show magnetic fields.

When a domain contains too many molecules, it becomes unstable and divides into two domains aligned in opposite directions, so that they stick together more stably, as shown at the right.

When exposed to a magnetic field, the domain boundaries move, so that the domains aligned with the magnetic field grow and dominate the structure (dotted yellow area), as shown at the left. When the magnetizing field is removed, the domains may not return to an unmagnetized state. This results in the ferromagnetic material's being magnetized, forming a permanent magnet.

When magnetized strongly enough that the prevailing domain overruns all others to result in only one single domain, the material is magnetically saturated. When a magnetized ferromagnetic material is heated to the Curie point temperature, the molecules are agitated to the point that the magnetic domains lose the organization, and the magnetic properties they cause cease. When the material is cooled, this domain alignment structure spontaneously returns, in a manner roughly analogous to how a liquid can freeze into a crystalline solid.

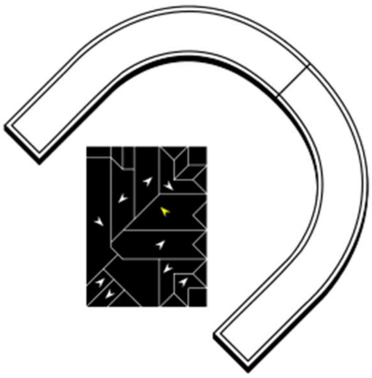

Fig 1.4 Magnetic domains boundaries (white lines) in ferromagnetic material (black rectangle)

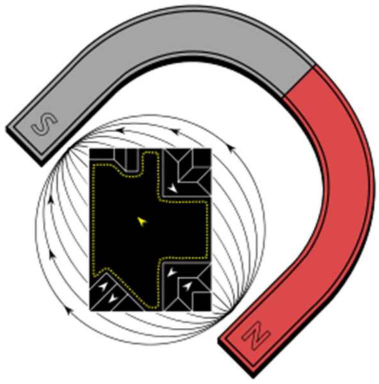

Fig 1.5 Effect of a magnet on the domains

1.3.5 Antiferromagnetism :

In an antiferromagnet, unlike a ferromagnet, there is a tendency for the intrinsic magnetic moments of neighboring valence electrons to point in opposite directions. When all atoms are arranged in a substance so that each neighbor is anti-parallel, the substance is antiferromagnetic. Antiferromagnets have a zero net magnetic moment, meaning that no field is produced by them. Antiferromagnets are less common compared to the other types of behaviors and are mostly observed at low temperatures. In varying temperatures, antiferromagnets can be seen to exhibit diamagnetic and ferromagnetic properties.

In some materials, neighboring electrons prefer to point in opposite directions, but there is no geometrical arrangement in which each pair of neighbors is anti-aligned. This is called a spin glass and is an example of geometrical frustration.

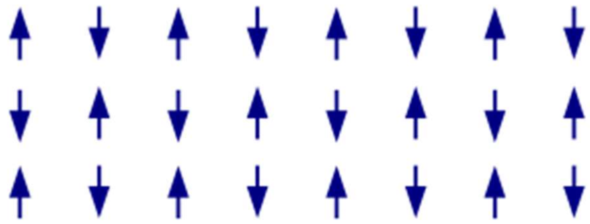

Fig 1.6 Antiferromagnetic ordering

1.3.6 Ferrimagnetism :

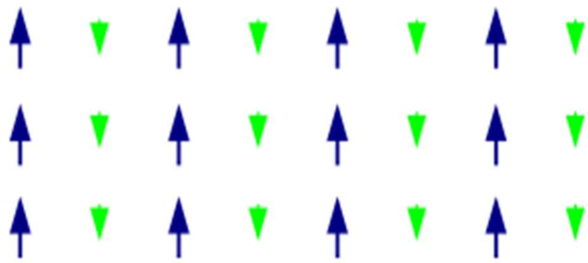

Fig 1.7 Ferrimagnetic ordering

Like ferromagnetism, ferrimagnets retain their magnetization in the absence of a field. However, like antiferromagnets, neighboring pairs of electron spins tend to point in opposite directions. These two properties are not contradictory, because in the optimal geometrical arrangement, there is more magnetic moment from the sublattice of electrons that point in one direction, than from the sublattice that points in the opposite direction.

Most ferrites are ferrimagnetic. The first discovered magnetic substance, magnetite, is a ferrite and was originally believed to be a ferromagnet; Louis Néel disproved this, however, after discovering ferrimagnetism.

1.3.7 Superparamagnetism :

When a ferromagnet or ferrimagnet is sufficiently small, it acts like a single magnetic spin that is subject to Brownian motion. Its response to a magnetic field is qualitatively similar to the response of a paramagnet, but much larger.

1.4 Magnetism, Electricity, And Special Relativity :

As a consequence of Einstein's theory of special relativity, electricity and magnetism are fundamentally interlinked. Both magnetism lacking electricity, and electricity without magnetism, are inconsistent with special relativity, due to such effects as length contraction, time dilation, and the fact that the magnetic force is velocity-dependent. However, when both electricity and magnetism are taken into account, the resulting theory (electromagnetism) is fully consistent with special relativity. In particular, a phenomenon that appears purely electric or purely magnetic to one observer may be a mix of both to another, or more generally the relative contributions of electricity and magnetism are dependent on the frame of reference. Thus, special relativity "mixes" electricity and magnetism into a single, inseparable phenomenon called electromagnetism, analogous to how relativity "mixes" space and time into spacetime.

All observations on electromagnetism apply to what might be considered to be primarily magnetism, e.g. perturbations in the magnetic field are necessarily accompanied by a nonzero electric field, and propagate at the speed of light.

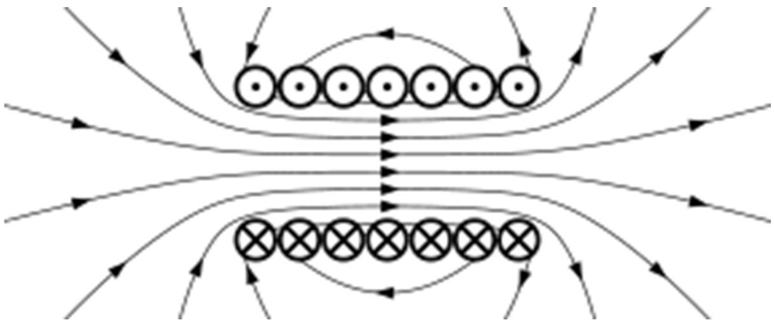

Fig 1.8 Electromagnetism

1.5 Magnetic Fields In A Material :

In a vacuum,

where $\mu 0$ is the vacuum permeability.

$B = \mu_0 H$,

In a material,

$B = \mu_0(H + m)$.

The quantity $\mu_0 M$ is called magnetic polarization.

If the field H is small, the response of the magnetization M in a diamagnet or paramagnet is approximately linear:

$M = {}_x H$,

the constant of proportionality being called the magnetic susceptibility. If so,

$\mu_0 (H + M) = \mu_0(1 + x)H = \mu_r \mu_0 H = {}_\mu H$.

In a hard magnet such as a ferromagnet, M is not proportional to the field and is generally nonzero even when H is zero.

Magnetic Field :

A magnetic field is a vector field that describes the magnetic influence on moving electric charges, electric currents, and magnetic materials. A moving charge in a magnetic field experiences a force perpendicular to its own velocity and to the magnetic field. A permanent magnet's magnetic field pulls on ferromagnetic materials such as iron, and attracts or repels other magnets. In addition, a magnetic field that varies with location will exert a force on a range of non-magnetic materials by affecting the motion of their outer atomic electrons. Magnetic fields surround magnetized materials, and are created by electric currents such as those used in electromagnets, and by electric fields varying in time. Since both strength and direction of a magnetic field may vary with location, it is described mathematically by a function assigning a vector to each point of space, called a vector field.

In electromagnetics, the term "magnetic field" is used for two distinct but closely related vector fields denoted by the symbols B and H. In the International System of Units, H, magnetic field strength, is measured in the SI base units of ampere per meter (A/m). B, magnetic flux density, is measured in tesla (in SI base units: kilogram per second2 per ampere), which is equivalent to newton per meter per ampere. H and B differ in how they account for magnetization. In a vacuum, the two fields are related through the vacuum permeability **$B/\mu_0 = H$;** but in a magnetized material, the terms differ by the material's magnetization at each point.

Magnetic fields are produced by moving electric charges and the intrinsic magnetic moments of elementary particles associated with a fundamental quantum property, their spin. Magnetic fields and electric fields are interrelated and are both components of the electromagnetic force, one of the four fundamental forces of nature.

Magnetic fields are used throughout modern technology, particularly in electrical engineering and electromechanics. Rotating magnetic fields are used in both electric motors and generators. The interaction of magnetic fields in electric devices such as transformers is conceptualized and investigated as magnetic circuits. Magnetic forces give information about the charge carriers in a material through the Hall effect. The Earth produces its own magnetic field, which shields the Earth's ozone layer from the solar wind and is important in navigation using a compass.

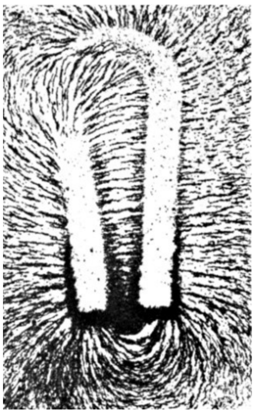

fig 1.9 The shape of the magnetic field

1.6 Magnetic Force :

The phenomenon of magnetism is "mediated" by the magnetic field. An electric current or magnetic dipole creates a magnetic field, and that field, in turn, imparts magnetic forces on other particles that are in the fields.

Maxwell's equations, which simplify to the Biot–Savart law in the case of steady currents, describe the origin and behavior of the fields that govern these forces. Therefore, magnetism is seen whenever electrically charged particles are in motion—for example, from movement of electrons in an electric current, or in certain cases from the orbital motion of electrons around an atom's nucleus. They also arise from "intrinsic" magnetic

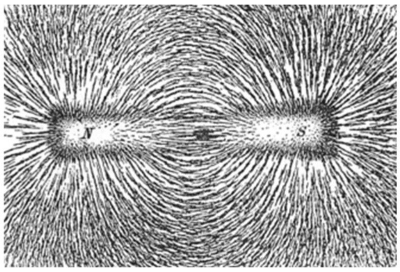

Fig 1.10 Magnetic lines of force of a bar magnet shown by iron filings on paper

The same situations that create magnetic fields—charge moving in a current or in an atom, and intrinsic magnetic dipoles—are also the situations in which a magnetic field has an effect, creating a force. Following is the formula for moving charge; for the forces on an intrinsic dipole, see magnetic dipole.

When a charged particle moves through a magnetic field **B**, it feels a Lorentz force **F** given by the cross product :

$$\mathbf{F} = q(\mathbf{V} \times \mathbf{B})$$

where

q is the electric charge of the particle, and
v is the velocity vector of the particle

Because this is a cross product, the force is perpendicular to both the motion of the particle and the magnetic field. It follows that the magnetic force does no work on the particle; it may change the direction of the particle's movement, but it cannot cause it to speed up or slow down. The magnitude of the force is

$$F = qvB \sin \Theta$$

where is the angle between **v** and **B**.

One tool for determining the direction of the velocity vector of a moving charge, the magnetic field, and the force exerted is labeling the index finger "V", the middle finger "B", and the thumb "F" with your right hand. When making a gun-like configuration, with the middle finger crossing under the index finger, the fingers represent the velocity vector, magnetic field vector, and force vector, respectively. See also right-hand rule.

2.0 WHAT IS MAGNET ?

2.1 Introduction :

A magnet is a material or object that produces a magnetic field. This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials, such as iron, steel, nickel, cobalt, etc. and attracts or repels other magnets.

A permanent magnet is an object made from a material that is magnetized and creates its own persistent magnetic field. An everyday example is a refrigerator magnet used to hold notes on a refrigerator door. Materials that can be magnetized, which are also the ones that are strongly attracted to a magnet, are called ferromagnetic (or ferrimagnetic). These include the elements iron, nickel and cobalt and their alloys, some alloys of rare-earth metals, and some naturally occurring minerals such as lodestone. Although ferromagnetic (and ferrimagnetic) materials are the only ones attracted to a magnet strongly enough to be commonly considered magnetic, all other substances respond weakly to a magnetic field, by one of several other types of magnetism.

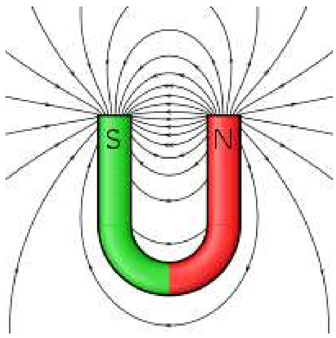

Fig 2.1 A "horseshoe magnet"

Ferromagnetic materials can be divided into magnetically "soft" materials like annealed iron, which can be magnetized but do not tend to stay magnetized, and magnetically "hard" materials, which do. Permanent magnets are made from "hard" ferromagnetic materials such as alnico and ferrite that are subjected to special processing in a strong magnetic field during manufacture to align their internal microcrystalline structure, making them very hard to demagnetize. To demagnetize a saturated magnet, a certain magnetic field must be applied, and this threshold depends on coercivity of the respective material. "Hard" materials have high coercivity, whereas "soft" materials have low coercivity. The overall strength of a magnet is measured by its magnetic moment or, alternatively, the total magnetic flux it produces. The local strength of magnetism in a material is measured by its magnetization.

An electromagnet is made from a coil of wire that acts as a magnet when an electric current passes through it but stops being a magnet when the current stops. Often, the coil is wrapped around a core of "soft" ferromagnetic material such as mild steel, which greatly enhances the magnetic field produced by the coil.

2.2 Working Process Of Magnet :

Magnetism is the force exerted by magnets when they attract or repel each other. Magnetism is caused by the motion of electric charges.

Every substance is made up of tiny units called atoms. Each atom has electrons, particles that carry electric charges. Spinning like tops, the electrons circle the nucleus, or core, of an atom. Their movement generates an electric current and causes each electron to act like a microscopic magnet.

In most substances, equal numbers of electrons spin in opposite directions, which cancels out their magnetism. That is why materials such as cloth or paper are said to be weakly magnetic. In substances such as iron, cobalt, and nickel, most of the electrons spin in the same direction. This makes the atoms in these substances strongly magnetic—but they are not yet magnets.

To become magnetized, another strongly magnetic substance must enter the magnetic field of an existing magnet. The magnetic field is the area around a magnet that has magnetic force.

All magnets have north and south poles. Opposite poles are attracted to each other, while the same poles repel each other. When you rub a piece of iron along a magnet, the north-seeking poles of the atoms in the iron line up in the same direction. The force generated by the aligned atoms creates a magnetic field. The piece of iron has become a magnet.

Some substances can be magnetized by an electric current. When electricity runs through a coil of wire, it produces a magnetic field. The field around the coil will disappear, however, as soon as the electric current is turned off.

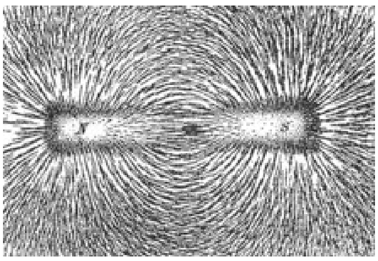

Fig 2.2 Iron filings that have oriented

Geomagnetic Poles :

The Earth is a magnet. Scientists do not fully understand why, but they think the movement of molten metal in the Earth's outer core generates electric currents. The currents create a magnetic field with invisible lines of force flowing between the Earth's magnetic poles.

The geomagnetic poles are not the same as the North and South Poles. Earth's magnetic poles often move, due to activity far beneath the Earth's surface. The shifting locations of the geomagnetic poles are recorded in rocks that form when molten material called magma wells up through the Earth's crust and pours out as lava. As lava cools and becomes solid rock, strongly magnetic particles within the rock become magnetized by the Earth's magnetic field. The particles line up along the lines of force in the Earth's field. In this way, rocks lock in a record of the position of the Earth's geomagnetic poles at that time.

Strangely, the magnetic records of rocks formed at the same time seem to point to different locations for the poles. According to the theory of plate tectonics, the rocky plates that make up the Earth's hard shell are constantly moving. Thus, the plates on which the rocks solidified have moved since the rocks recorded the position of the geomagnetic poles. These magnetic records also show that the geomagnetic poles have reversed—changed into the opposite kind of pole—hundreds of times since the Earth formed.

Earth's magnetic field does not move quickly or reverse often. Therefore, it can be a useful tool for helping people find their way around. For hundreds of years, people have used magnetic compasses to navigate using Earth's magnetic field. The magnetic needle of a compass lines up with Earth's magnetic poles. The north end of a magnet points toward the magnetic north pole.

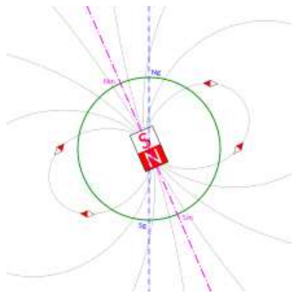

fig 2.3 Illustration of the difference between geomagnetic

Earth's magnetic field dominates a region called the magnetosphere, which wraps around the planet and its atmosphere. Solar wind, charged particles from the sun, presses the magnetosphere against the Earth on the side facing the sun and stretches it into a teardrop shape on the shadow side.

The magnetosphere protects the Earth from most of the particles, but some leak through it and become trapped. When particles from the solar wind hit atoms of gas in the upper atmosphere around the geomagnetic poles, they produce light displays called auroras. These auroras appear over places like Alaska, Canada and Scandinavia, where they are sometimes called "Northern Lights." The "Southern Lights" can be seen in Antarctica and New Zealand.

2.3 Type Of Magnet :

Fig 2.4 Types Of Magnet

2.3.1 Permanent Magnet :

Permanent magnets are those magnets that are commonly used. They are known as permanent magnets because they do not lose their magnetic property once they are magnetized.

Type Permanent Magnet :

2.3.1.1 Ceramic :

Ceramic, also known as Ferrite, magnets are made of a composite of iron oxide and barium or strontium carbonate. These materials are readily available and at a lower cost than other types of materials used in permanent magnets making it desirable due to the lower cost. Ceramic magnets are made using pressing and sintering. These magnets are brittle and require diamond wheels if grinding is necessary. These magnets are also made in different grades. Ceramic-1 is an isotropic grade with equal magnetic properties in all directions. Ceramic grades 5 and 8 are anisotropic grades. Anisotropic magnets are magnetized in the direction of pressing. The anisotropic method delivers the highest energy product among ceramic magnets at values up to 3.5 MGOe (Mega Gauss Oersted). Ceramic magnets have a good balance of magnetic strength, resistance to demagnetizing and economy. They are the most widely used magnets today.

Positive	Negative
Low Cost	Low Energy Product
High Coercive Force	Low Mechanical Strength - Brittle
High Resistance to Corrosion	

2.3.1.2 Alnico :

Alnico magnets are made up of a composite of aluminum, nickel and cobalt with small amounts of other elements added to enhance the properties of the magnet. Alnico magnets have good temperature stability, good resistance to demagnetization due to shock but they are easily demagnetized. Alnico magnets are produced by two typical methods, casting or sintering. Sintering offers superior mechanical characteristics, whereas casting delivers higher energy products (up to 5.5 MGOe) and allows for the design of intricate shapes. Two very common grades of Alnico magnets are 5 and 8. These are anisotropic grades and provide for a preferred direction of magnetic orientation. Alnico magnets have been replaced in many applications by ceramic and rare earth magnets.

Positive	Negative
High Corrosion Resistance	High Cost
High Mechanical Strength	Low Coercive Force
High Temperature Stability	Low Energy Product

2.3.1.3 Samarium Cobalt :

Samarium cobalt is a type of rare earth magnet material that is highly resistant to oxidation, has a higher magnetic strength and temperature resistance than Alnico or Ceramic material. Introduced to the market in the 1970's, samarium cobalt magnets continue to be used today. Samarium cobalt magnets are divided into two main groups: Sm_1Co_5 and Sm_2Co_{17} (commonly referred to as 1-5 and 2-17). The energy product range for the 1-5 series is 15 to 22 MGOe, with the 2-17 series falling between 22 and 32 MGOe. These magnets offer the best temperature characteristics of all rare earth magnets and can withstand temperatures up to 300° C. Sintered samarium cobalt magnets are brittle and prone to chipping and cracking and may fracture when exposed to thermal shock. Due to the high cost of the material samarium, samarium cobalt magnets are used for applications where high temperature and corrosion resistance is critical.

Positive	Negative
High Corrosion Resistance	High Cost
High Energy Product	Low Mechanical Strength - Brittle
High Temperature Stability	
High Coercive Force	

2.3.1.4 Neodymium Iron Boron :

Neodymium Iron Boron (NdFeB) is another type of rare earth magnetic material. This material has similar properties as the Samarium Cobalt except that it is more easily oxidized and generally doesn't have the same temperature resistance. NdFeB magnets also have the highest energy products approaching 50MGOe. These materials are costly and are generally used in very selective applications due to the cost. Cost is also driven by existing intellectual property rights of the developers of this type of magnet. Their high energy products lend themselves to compact designs that result in innovative applications and lower manufacturing costs. NdFeB magnets are highly corrosive. Surface treatments have been developed that allow them to be used in most applications. These treatments include gold, nickel, zinc and tin plating and epoxy resin coating.

Positive	Negative
Very High Energy Product	Higher Cost (Except from us!)
High Coercive Force	Low Mechanical Strength - Brittle
	Moderate Temperature Stability
	Low Corrosion Resistance (When uncoated)

2.3.1.5 Injection Molded :

Injection moldable magnets are a composite of resin and magnetic powders of different materials allowing parts to be made in an injection molding process. Energy products are dependent upon the magnetic powders used in fabrication. The molding process allows for the manufacture of more complex shapes. These magnets are usually lower in magnetic strength as there are limitations to the degree of loading.

Positive	Negative
Moderate Energy Product	High Cost
Moderate Coercive Force	Low Temperature Stability
High Corrosion Resistance	
Highly Shapeable	

2.3.1.6 Flexible :

Flexible magnets are very similar to the injection molded magnets but are produced in flat strips and sheets. These magnets are lower in magnetic strength and very flexible depending on the materials that was used in the compound with the magnetic powders. Vinyl is often used in this type of magnet as the binder.

Positive	Negative
Low Cost	Low Energy Product
High Corrosion Resistance	Low to Medium Temperature Stability
Moderate Coercive Force	

2.3.2 Temporary Magnet :

Fig 2.5 Temporary

Temporary magnets are a type of magnet that occurs artificially (human-made) in nature. These magnets are created from soft metals. Magnetism can be induced in a magnetic material in the presence of a permanent magnetic field or electronic current, or any other external magnetic field. Those materials are known as Permanent magnets. These magnets lose their magnetic property once you remove the magnetic field. For Example, Paperclips, iron nails, and similar materials act as temporary magnets in the presence of an external magnetic field.

In a nutshell, a Temporary Magnet:

1. Can only form the magnetic field in the presence of a permanent or stronger magnet. In simple terms, temporary magnets require assistance from an external source to pull other objects and magnets.
2. Necessitate support from the more significant external force to exercise energy on other materials.

2.3.2.1 What Can Be Considered A Temporary Magnet?

Below given are few essential points that would assist you in identifying the properties of a Temporary Magnet:

1. You can easily make a temporary magnet with the assistance of magnetic objects.
2. Temporary magnets are available in various types and forms. For instance, an electromagnet is also a type of temporary magnet that retains the magnetic properties whenever the ion coils inside it pass through an electrical current. Therefore making it active to react with nearby objects.
3. The above example of electromagnets is one of the more prominent temporary magnets that briefly explains the concept of temporary magnets, how it works and demonstrates that electromagnets will not act without a more robust magnetic field or electric current (in the case of electromagnets).
4. The electromagnet is also known as artificial magnets because they are made up of a network of electric coiled wires instead of a more natural magnetizing method.
5. Apart from electromagnets, there are other examples of temporary magnets you might be using daily without knowing their exact nature, such as doorbells or complex motors. Temporary magnets can include any magnetic material that can be converted into a magnet for a short period. Hence they are termed "temporary" magnets.
6. Since temporary magnets can only use their magnetic force in distinct controlled circumstances, the material will not retain its properties after the external magnetic field forces have worn off.
7. Though it is almost impossible to name each substance that can be regarded as a temporary magnet, therefore it is necessary to note that temporary magnets can only be formed through an external magnetic field.
8. To be more precise, the process of temporary magnetism is done by inducing the material in direct contact with a permanent magnet, possessing a strong magnetic field.
9. Hence we can conclude that temporary magnets can be quickly created and destroyed.
10. The temporary magnet gets demagnetized when the stronger magnetic field is removed from it. Therefore, all the temporary magnets are not considered strong magnets as they are dependent on other strong magnets. Their magnetic properties become active only in the presence of an external magnetic source.

2.3.3 Electromagnets :

The electromagnets are temporary magnets that are created when the electricity passes through a metal wire coil. When electricity passes through the metal coil, the electric field creates the magnetic field at the core or centre of the coil. This magnetic field can be made more powerful by introducing an iron rod in the centre of the coil. Since iron metal has the intrinsic property to retain the magnetic field the insertion of the iron rod at the centre make it a powerful magnet but it is a temporary magnet.

When the current is turned off, the iron rod with powerful magnetic core becomes a simple iron rod without magnetic property. These magnets are different from permanent magnets as permanent magnets do not require electricity to create the magnetic field. The change in the strength of the magnetic field created by the electric current passing through the coil is by changing the amount of electric current.

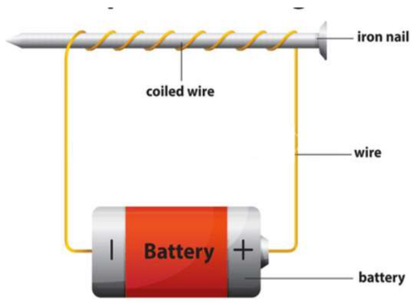

Fig 2.6 Electromagnet

Advantages And Disadvantages Of Electromagnets :

Advantages :

Electromagnets are very useful where the changing of poles and discontinuation of the magnetic field is necessary. A magnetic separator utilises this property of electromagnets very well. When magnetized by passing current, it attracts the iron scraps from the heap of scraps and its operator moves the scrap to another place and stops the current supply to drop them. By deploying magnetic separator, we get iron scrap.

Other advantages of electromagnets are that they are inexpensive and easy to build. They are lightweight and do not damage the test-piece which is a part of the electromagnet.

Disadvantages :

One of the disadvantages of electromagnets is that they heat up very fast and due to this heat generation lose of electrical energy is very much. A continuous power supply requires maintaining the constant magnetic field. To get the strong magnetic field, a large number of coiling of copper wire is required which in turn, requires large space. So the electromagnets are unfit for small spaces. As the magnetic field is due to the electric current in electromagnets, short-circuit can damage the electromagnets and they can harm the operator badly.

2.3.3.1 Resistant :

A Resistant magnet produces a magnetic field with copper wires. As electricity runs through the wire, the electrons produce a weak magnetic field. Then, if you twist a wire around a piece of metal, say iron, you help concentrate that magnetic field around the iron. The more you twist the wire, the stronger the field.

You can also use stacks of copper plates, usually Bitter plates. Named after their inventor, Francis Bitter, Bitter plates contain holes that allow water to pass through and cool the magnets, which allows the magnets to produce a stronger magnetic field. On the downside, it takes a costly amount of electricity and water to keep these resistive magnets running.

2.3.3.2 Uperconductor Magnets :

uperconductor electromagnets operate by reducing electrical resistance: While a current runs through a copper plate, atoms in the copper interfere with the electrons in the current. Thus, superconducting magnets use liquid nitrogen or liquid helium to produce very cold temperatures. The cold keeps the copper atoms out of the way, and these electromagnets will keep running even when the power's turned off.

According to Florida State University's Magnet Lab, uperconductor electromagnets have vast potential. Scientists, as of 2010, are using them to improve technology for medical imaging and develop levitating trains.

2.3.3.3 Hybrid Electromagnets :

Hybrid electromagnets combine resistive electromagnets with superconducting electromagnets. The design of hybrid electromagnets vary, but the hybrid at Florida State University's Magnet Lab weighs 35 tons, stands over 20 feet tall and contains enough copper wire for 80 average homes. Deionized water, or water without an electrical charge, keeps this hybrid magnet chugging along more than 400 degrees F below freezing point.

The Lawrence Berkeley National Laboratory also develops hybrid electromagnets. In January 2010, scientists there developed a new type of hybrid for molecular research.

2.4 Electricity And Magnetism :

The flow of electrons is called electricity. As electrons move through a wire, they create a magnetic field. Scientists believe that magnetism and electricity are part of a single force. It is called the electromagnetic force.

Danish physicist Hans Christian Oersted discovered electromagnetism in 1820. The discovery led to major improvements in the way people live. Scientists began to produce magnets by sending electricity through a coil of wire wrapped around a magnetic material, like iron. This type of magnet is called an electromagnet. Electromagnets can vary in strength. The strength depends on the size of the electric current and the number of times a wire is coiled. Powerful electromagnets, for example, are used to lift cars in junkyards.

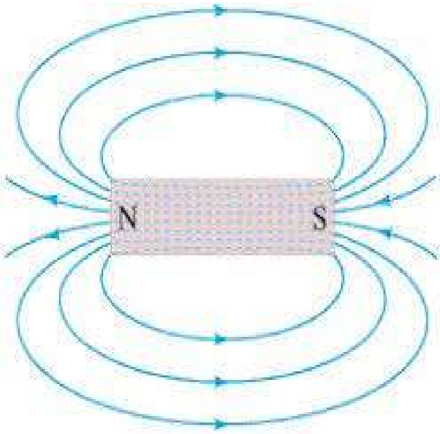

Fig 2.7 Electricity and Magnetism

2.5 Use Of Magnet :

Magnets are found in many devices that people use every day. They are in any machine that has a motor. That includes fans, washing machines, and cars. Motors use magnets and coils of wire to turn electrical energy into motion.

Magnets have also helped bring about major advances in health care and transportation. Doctors can diagnose medical conditions through MRI, or magnetic resonance imaging. MRI devices use a magnetic field to create pictures of patients' organs. In Japan, China, and Germany, high-speed trains use magnets to reach speeds topping 300 miles per hour. The magnets allow the trains to float above the tracks. This gets rid of the friction that would otherwise cause the trains to move at slower speeds.

Magnetism is a basic force of nature. It surrounds us. Understanding how magnets work has inspired people to develop groundbreaking and lifesaving technologies.

2.8 Use Of Magnet

3.0 WHAT IS MAGNETIC FLUX ?

3.1 Introduction :

Magnetic flux is a measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effects of the magnetic force on something occupying a given area. The measurement of magnetic flux is tied to the particular area chosen. We can choose to make the area any size we want and orient it in any way relative to the magnetic field.

If we use the field-line picture of a magnetic field then every field line passing through the given area contributes some magnetic flux. The angle at which the field line intersects the area is also important. A field line passing through at a glancing angle will only contribute a small component of the field to the magnetic flux. When calculating the magnetic flux we include only the component of the magnetic field vector which is normal to our test area.

If we choose a simple flat surface with area A as our test area and there is an angle θ between the normal to the surface and a magnetic field vector (magnitude B) then the magnetic flux is, More generally, the magnetic flux can be found using the vector dot product. If B is a magnetic field vector and A is the surface-normal vector to the test area then

$$\Phi = \vec{B} \cdot \vec{A}.$$

$$\Phi = BA\cos\theta$$

In the case that the surface is perpendicular to the field then the angle is zero and the magnetic flux is simply B A. Figure 1 shows an example of a flat test area at two different angles to a magnetic field and the resulting magnetic flux.

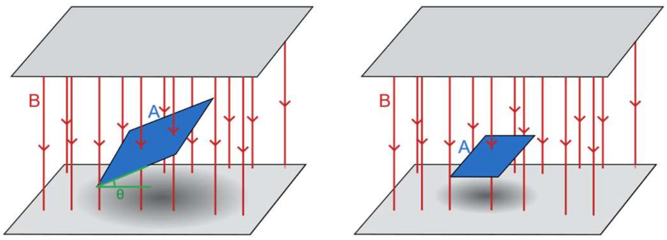

Fig 3.1 ***Magnetic flux through given areas (blue) oriented at an angle (left) and normal to (right) the magnetic field.***

3.2 Magnetic Field Lines:

A magnetic field line is defined as a curve drawn in the magnetic field in such a way that the tangent to the curve at any point gives the direction of the magnetic field. They start at the North Pole and end at the South Pole. The magnetic field at a point is tangential to the magnetic field lines.

The right hand thumb rule can be used to determine the direction of magnetic lines around a current carrying conductor. Hold the wire with four fingers of your right hand with your thumb up. If the direction of the current is towards the thumb, then the magnetic lines curl in the same direction as your other four fingers. This shows that the magnetic field is always perpendicular to the direction of the current.

The magnetic field strength at a given position due to current carrying wire is determined by

- The current flowing across the wire
- The point's distance from the wire
- The point's angle from the wire
- The magnetic nature of the medium.

The magnetic field lines are stronger near the current carrying wire and it diminishes as you go away from it. This is represented by drawing magnetic field lines closer together near the wire and farther away from the wire.

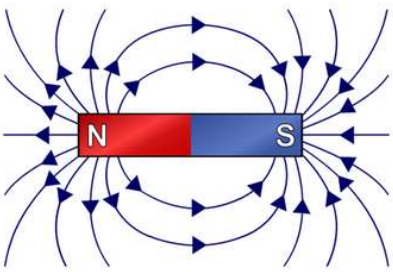

Fig 3.2 Magnetic field lines

3.3 What Is Magnetic Flux And The Unit Of Magnetic Flux Is? Define Magnetic Flux :

Magnetic flux definition and Magnetic flux meaning: Magnetic flux refers to the total number of magnetic field lines penetrating any surface placed perpendicular to the magnetic field. The overall magnetic field that traverses across a specific area is determined by magnetic flux physics. It's a valuable tool for identifying the effects of magnetic force on things in a particular location.

In physics, generally electromagnetic induction, the magnetic flux throughout the surface integration of the normal component of the magnetic field B over a surface is the magnetic flux throughout that surface. It is commonly indicated by the symbol ø or øB. The SI unit of magnetic flux is weber(Wb), while the maxwell is the CGS unit.

The magnetic interaction is characterized as a vector field, in which each point in space is designated a vector that indicates the force that a moving charge will encounter at that position. Because a vector field is difficult to interpret at first, field lines would be used to describe it in fundamental physics.

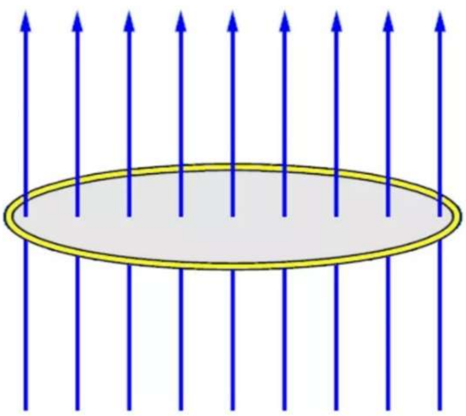

Fig 3.3 Magnetic Flux

The number of field lines determines the magnetic flux through a surface that flows through it; the flux can be specifically defined as the number of field lines that pass through it. The magnetic flux is the difference between the number of field lines going through a surface in one direction and the number passing through in the other direction.

The magnetic flux ∅ linked with a surface held in a magnetic field B is defined as the number of magnetic lines of force crossing a closed area A. If is the angle between the field's direction and the area's normal, then

∅=B.A

∅=BAcos

Whenever there is a change in the magnetic flux linked with a closed circuit, an electromotive force is produced. This electro motive force is known as the induced electromotive force and the current that flows in the closed circuit is called induced current.

The phenomenon of producing an induced electromotive force due to the changes in the magnetic flux associated with a closed circuit is known as electromagnetic induction.

Properties Of Magnetic Lines Of Force :

- Magnetic lines of force are enclosed, continual curves that extend through the magnet's body.
- It originates at the North Pole and ends at the South Pole.
- Magnetic lines of force never overlap one another.
- The magnetic field direction is determined by establishing a tangent at any point on the curved line.
- Magnetic lines of force will be greater at the poles than at the equator.

3.4 Magnetic Flux Through A Closed Surface :

Gauss's law for magnetism, which is one of the four Maxwell's equations, states that the total magnetic flux through a closed surface is equal to zero. (A "closed surface" is a surface that completely encloses a volume(s) with no holes.) This law is a consequence of the empirical observation that magnetic monopoles have never been found.

In other words, Gauss's law for magnetism is the statement:

$$\Phi_B = \oint\!\!\!\oint_S \mathbf{B} \cdot d\mathbf{S} = 0$$

for any closed surface S.

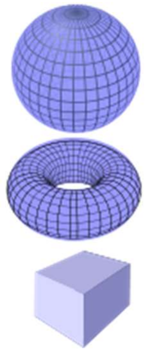

Fig 3.4 Closed Surface

3.5 Magnetic Flux Through An Open Surface :

While the magnetic flux through a closed surface is always zero, the magnetic flux through an open surface need not be zero and is an important quantity in electromagnetism.

When determining the total magnetic flux through a surface only the boundary of the surface needs to be defined, the actual shape of the surface is irrelevant and the integral over any surface sharing the same boundary will be equal. This is a direct consequence of the closed surface flux being zero.

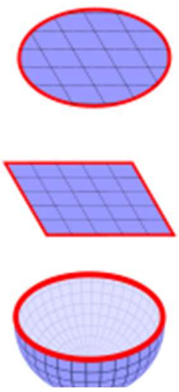

Fig 3.5 open surface

3.6 Changing Magnetic Flux :

For example, a change in the magnetic flux passing through a loop of conductive wire will cause an electromotive force, and therefore an electric current, in the loop. The relationship is given by Faraday's law:

$$\mathcal{E} = \oint_{\partial\Sigma} (\mathbf{E} + \mathbf{v} \times \mathbf{B}) \cdot d\boldsymbol{\ell} = -\frac{d\Phi_B}{dt},$$

Where

- $\mathcal{E}$ is the electromotive force (EMF),
- ΦB is the magnetic flux through the open surface Σ,
- ∂Σ is the boundary of the open surface Σ; the surface, in general, may be in motion and deforming, and so is generally a function of time. The electromotive force is induced along this boundary.
- dℓ is an infinitesimal vector element of the contour ∂Σ,
- v is the velocity of the boundary ∂Σ,
- E is the electric field,
- B is the magnetic field.

The two equations for the EMF are, firstly, the work per unit charge done against the Lorentz force in moving a test charge around the (possibly moving) surface boundary ∂Σ and, secondly, as the change of magnetic flux through the open surface Σ. This equation is the principle behind an electrical generator.

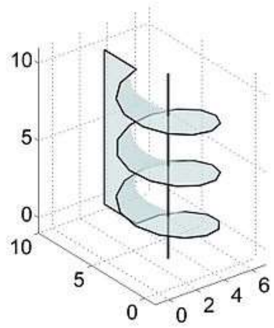

Fig 3.6 Area defined by an electric coil with three turns.

3.7 What is magnetic flux density formula? Define Magnetic flux density? :

Magnetic flux density is the quantity of magnetic flux per unit area measured perpendicular to the magnetic flux direction. B=μH is the relationship between Flux density B and Magnetic Field (H). It is expressed in Webers per square metre, which is equal to Tesla [T]. The number of magnetic field lines crossing unit area kept normal to the direction of the field lines.

A vector field is magnetic flux density. The magnetic flux flow is generally directed from the North Pole to the South Pole. Furthermore, these magnetic lines create complete loops that exit at the North Pole and enter at the south pole of the magnet. Magnetic poles are always found in groups of two. The flux density is expressed as the proportion of uniformly dispersed flux per unit area of the cross-section it acts through.

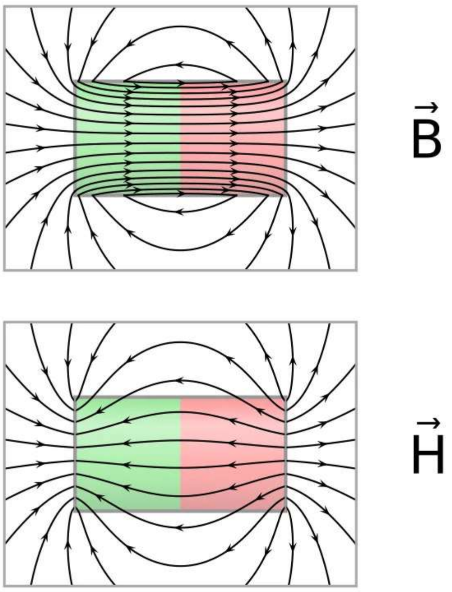

Fig 3.7 Magnetic Flux Density

The product of the magnetic permeability of a medium by the intensity of the magnetic field in it, and induction of magnetism in a body while it is in a magnetic field or in the magnetic flux generated up by a magneto motive force. When a charged particle accelerates, it is subjected to a force known as the magnetic field, magnetic induction, or magnetic flux intensity. The method of constructing electric current with a magnetic field is known as electromagnetic induction. When a magnetic field and an electric conductor move relative to one another, the conductor crosses the magnetic field's lines of force. Many electrical appliances are powered by electromagnetic induction. Electrical generators are one of the most well-known applications.

The relation between the flux density and vector potential:

The magnetic field is the curl of the magnetic vector potential, as per the relationship between magnetic field strength and magnetic vector potential. The space derivative of the magnetic vector potential A can be used to compute the magnetic flux density B.

B = Curl (A)

3.8 Magnetic Circuit:

One or more closed loop channels containing a magnetic flux cover a magnetic circuit. Permanent magnets or electromagnets generate the flux, which is controlled to the path by magnetic cores made of ferromagnetic components like iron, though there may be air gaps or other materials in the path.

In an air gap, a magnetic circuit is used to create alternate portions of high and low magnetic fields. A magnetic circuit is a closed path that is followed by magnetic flux. Flux in a magnetic circuit originates at one place and ends at the same location.

3.9 Flux Meter :

A flux metre is a tool for determining the magnetic flux of a permanent magnet. This apparatus has been used to measure the magnetic features of the earth's magnetic field since the 19th century.. There have been significant advancements in its design, and digital flux metres are now available on the market. The flux metre is a more advanced version of the ballistic galvanometer.

Working principle of Flux meter :

The basis of operation of a flux metre is based on Faraday's law. When a conductor is positioned between shifting magnetic fields, a voltage is induced in the conductor, according to Faraday's law of electromagnetic induction. Similarly, a voltage is induced in a moving conductor when it is put between two stable magnets. This induced voltage will be proportional to the flux rate of change. As a result, the flux metre is made up of a moving coil sandwiched between the magnetic fields of two permanent magnets that are both steady. A calibration metre is used to calculate the voltage change in the coil. This value indicates how much flex is there in the field

3.10 Light Flux Density :

The rate at which energy is transported by electromagnetic radiation through the use of a real or virtual surface, per unit surface area and per unit wavelength, is referred to as spectral flux density in spectroscopy.

3.11 Ratio of magnetic flux and induced current :

It implies that induced current inhibits the magnetic field. As a result, a change in flux causes a current and a voltage that are proportional to the rate of flux change. This is in accordance with Ohm's Law (V = IR). In a coil, a current and voltage generate a flux that is proportional to the current and voltage.

3.12 Faraday's law of induction :

Faraday's law of induction (briefly, Faraday's law) is a basic law of electromagnetism predicting how a magnetic field will interact with an electric circuit to produce an electromotive force (EMF)—a phenomenon known as electromagnetic induction. It is the fundamental operating principle of transformers, inductors, and many types of electrical motors, generators and solenoids.

The Maxwell–Faraday equation (listed as one of Maxwell's equations) describes the fact that a spatially varying (and also possibly time-varying, depending on how a magnetic field varies in time) electric field always accompanies a time-varying magnetic field, while Faraday's law states that there is EMF (electromotive force, defined as electromagnetic work done on a unit charge when it has traveled one round of a conductive loop) on the conductive loop when the magnetic flux through the surface enclosed by the loop varies in time.

Faraday's law had been discovered and one aspect of it (transformer EMF) was formulated as the Maxwell–Faraday equation later. The equation of Faraday's law can be derived by the Maxwell–Faraday equation (describing transformer EMF) and the Lorentz force (describing motional EMF). The integral form of the Maxwell–Faraday equation describes only the transformer EMF, while the equation of Faraday's law describes both the transformer EMF and the motional EMF.

4.0 ACTUAL PROCEDURE FOLLOWED

For this project we are follow the following procedure :

1. **First we are making list of group members:**

   Name of the members :

   1. Devendra buwa
   2. Niraj Bava
   3. Syed Danish Ali
   4. Omar Siddique

2. **Second dividing work in 4 members in following path :**

   1. Work for member first is collecting information form internet and web platform.
   2. Work for members second is verifying information and type all the information in one word file, beautify and filtering the text.
   3. Work for member third is making chart and collecting graphics for chart and attached it on chart.
   4. Work for member fourth is printing all the word document and file it.

3. **Third collecting project report and chart form group members.**

5.0 ACTUAL RESOURCES USED

LIST OF RESOURCES

SR NO	NAME	LINKS
1	school.careers360.com	https://school.careers360.com/physics/magnetic-flux-topic-pge
2	byjus.com	https://byjus.com/physics/magnet/
3	en.wikipedia.org	https://en.wikipedia.org/wiki/Magnet
4	timeforkids.com	https://www.timeforkids.com/g34/what-are-magnets-2/
5	en.wikipedia.org	https://en.wikipedia.org/wiki/Magnetism#Types_of_magnetism
6	magcraft.com	https://www.magcraft.com/types-of-permanent-magnets
7	javatpoint.com	https://www.javatpoint.com/temporary-magnets
8	toppr.com	https://www.toppr.com/guides/physics/electromagnetism/what-are-electromagnets/
9	khanacademy.org	https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields/magnetic-flux-faradays-law/a/what-is-magnetic-flux#:~:text=Magnetic%20flux%20is%20a%20measurement,something%20occupying%20a%20given%20area.
10	nationalgeographic.org	https://www.nationalgeographic.org/encyclopedia/magnetism/

6.0 SKILL DEVELOPMENT / LEARNING OUT OF MICRO-PROJECT

The learning out of this project is we're getting detailed information about **magnet**, **magnetism** and getting brief information about **magnetic flux**. We're know about magnet is very important metal and it's use in very large quantity in industry. We are also use magnet in our daily routine life. Magnet is metal and it's also have different types like permanent magnet, temporary magnet and electromagnet those are type of magnet. Magnet also have different type of properties like Magnetism and magnetic flux those are types of properties of magnet.

We're use magnet in our daily life devices like mobile phone, speakers, televisions like devices. Magnet is also use in different type of industry like medical industry, manufacturing industry, electronic industry etc. are use different types of magnet in there work. Magnet is metal and it's main property is magnetism, it's a power of magnet this is a principle thing of magnet and it's working process. In this project we're learning out about those all the points of information.