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***CLASS: BSCS 1 st YEAR.***

***SECTION: A.***

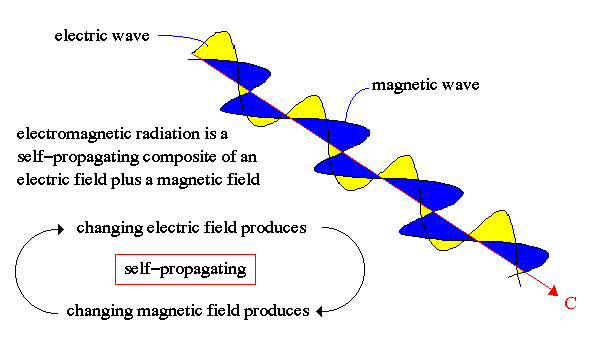
***SUBJECT: PHYSICS.***

1. ***RELATIONSHIP BETWEEN CURRENT AND MAGNETIC FIELDS:***

Although conceived of as distinct phenomena until the 19th century, electricity and magnetism are known to be components of the unified theory of electromagnetism.

A connection between electricity and magnetism had long been suspected, and in 1820 the Danish physicist Hans Christian Orated showed that an electric current flowing in a wire produces its own magnetic field. Andre-Marie Ampere of France immediately repeated Orsted’s experiments and within weeks was able to express the magnetic forces between current-carrying conductors in a simple and elegant mathematical form. He demonstrated that a current flowing in a loop of wire produces a magnetic dipole indistinguishable at a distance from that produced by a small permanent magnet; this led Ampere to suggest that magnetism is caused by currents circulating on a molecular scale, an idea remarkably near the modern understanding.

The unification of electric and magnetic phenomena in a complete mathematical theory was the achievement of the Scottish physicist Maxwell (1850's). In a set of four elegant equations, Maxwell formalized the relationship between electric and magnetic fields. In addition, he showed that a linear magnetic and electric field can be self-reinforcing and must move at a particular velocity, the speed of light. Thus, he concluded that light is energy carried in the form of opposite but supporting electric and magnetic fields in the shape of waves, i.e. self-propagating electromagnetic waves.



In doing this, Maxwell moved physics to a new realm of understanding. By using field theory as the core to electromagnetism, we have moved beyond a Newtonian worldview where objects change by direct contact and into a theory that uses invisible fields. This introduces a type of understanding which can only be described with a type of mathematics that cannot be directly translated into language. In other words, scientists where restricted in talking about electromagnetic phenomenon strictly through the use of a new type of language, one of pure math.

***DESCRIPTION:***

Electricity and magnetism are closely related to each other. The electric current

Flowing through the wire produces a circular magnetic field outside the wire. The

Direction (clockwise or counter-clock wise) of this magnetic field is depends on the

Direction of the electric current. One way to explore the direction of a magnetic

Field is with a compass, as shown by a long straight current-carrying wire in. Hall

Probes can determine the magnitude of the field. Another version of the right hand

Rule emerges from this exploration and is valid for any current segment—point the

Thumb in the direction of the current, and the fingers curl in the direction of the

Magnetic field loops created by it.

Magnitude of Magnetic Field from Current:

The equation for the magnetic field strength (magnitude) produced by a long

Straight current-carrying wire is:

B=μ0I/2πr

For a long straight wire where I is the current, r is the shortest distance to the wire,

And the constant 0 =4π10 −7 T⋅m/A is the permeability of free space. (μ 0 is one of the

Basic constants in nature, related to the speed of light.) Since the wire is very long,

The magnitude of the field depends only on distance from the wire r, not on

Position along the wire. This is one of the simplest cases to calculate the magnetic

Field strength from a current.

A more fundamental law than the Biot-Savart law is Ampere’s Law, which relates

Magnetic field and current in a general way. Ampere&#39;s Law states that for any

Closed loop path, the sum of the length elements times the magnetic field in the

Direction of the length element is equal to the permeability times the electric

Current enclosed in the loop.

***2. PHOTOELECTRIC EFFECT:***

***INTRODUCTION:***

The photoelectric effect is a phenomenon in physics. The effect is based on the idea that electromagnetic radiation is made of a series of particles called photons. When a photon hits an electron on a metal surface, the electron can be emitted. The emitted electrons are called photoelectrons. This effect is also called the ***Hertz Effect*,** it was discovered by *Heinrich Rudolf Hertz, but this name is not used often.*

Einstein (1905) successfully resolved this paradox by proposing that the incident light consisted of individual quanta, called photons that interacted with the electrons in the metal like discrete particles, rather than as continuous waves. For a given frequency, or 'color,' of the incident radiation, each photon carried the energy E = hf, where h is Planck's constant and f is the frequency. Increasing the intensity of the light corresponded, in Einstein's model, to increasing the number of incident photons per unit time (flux), while the energy of each photon remained the same (as long as the frequency of the radiation was held constant).   
  
Clearly, in Einstein's model, increasing the intensity of the incident radiation would cause greater numbers of electrons to be ejected, but each electron would carry the same average energy because each incident photon carried the same energy. [This assumes that the dominant process consists of individual photons being absorbed by and resulting in the ejection of a single electron.] Likewise, in Einstein's model, increasing the frequency f, rather than the intensity, of the incident radiation would increase the average energy of the emitted electrons.

***THRESHOLD FREQUENCY***

Not every electromagnetic wave will cause the photoelectric effect, only radiation of a certain frequency or higher will cause the effect. The minimum frequency needed is called the “Cutoff frequency” or “Threshold frequency”. The cutoff frequency is used to find the **work function,** w, which is the amount of energy required to hold the electron on the surface of metal.

***WORK FUNCTION***

The work function is a property of the metal and is not affected by the incoming radiation. If a frequency of light strikes the metal surface that is greater thann the cutoff frequency, then the emitted electron will have some kinetic energy,

***MECHANISM:***

When light shines on metal, electrons can be ejected from the surface of the metal

In a phenomenon known as the photoelectric effect. This process is also often

Referred to as photoemission, and the electrons that are ejected from the metal are

Called photoelectrons. In terms of their behavior and their properties,

Photoelectrons are no different from other electrons. The prefix, photo-, simply

Tells us that the electrons have been ejected from a metal surface by incident light.

Predictions based on light as a wave:

To explain the photoelectric effect, 19th-century physicists theorized that the

Oscillating electric field of the incoming light wave was heating the electrons and

Causing them to vibrate, eventually freeing them from the metal surface. Based on

The classical description of light as a wave, they made the following predictions:

The kinetic energy of emitted photoelectrons should increase with the light

Amplitude.

The rate of electron emission, which is proportional to the measured electric

Current, should increase as the light frequency is increased.

When intuition fails: photons to the rescue.

When experiments were performed to look at the effect of light amplitude and

Frequency, the following results were observed:

The kinetic energy of photoelectrons increases with light frequency.

Electric current remains constant as light frequency increases.

Electric current increases with light amplitude.

The kinetic energy of photoelectrons remains constant as light amplitude Increases.

These results were completely at odds with the predictions based on the classical

Description of light as a wave! In order to explain what was happening, it turned

Out that an entirely new model of light was needed. That model was developed by

Albert Einstein, who proposed that light sometimes behaved as particles of

Electromagnetic energy which we now call photons. The energy of a photon could

Be calculated using Planck’s equation:

E photon =hν

We can analyze the frequency relationship using the law of conservation of energy.

The total energy of the incoming photon, E photon, must be equal to the kinetic energy

Of the ejected electron, K Electron, plus the energy required to eject the electron from

The metal. This can be written as:

E photon ​​=K E​electron ​​+Φ

***3. CAPACITANCE AND ITS APPLICATIONS:***

***INTRODUCTION:***

Capacitor: “A capacitor is an electronic device which is used to store energy in the form of charge to provide a certain potential difference across its plates to any electric appliance which is needed by that appliance to function properly.”

There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitor s, but they all have the same functionality i.e., they store charge.

In its basic form, a capacitor consists of two or more parallel conductive (metal) plates which are not connected or touching each other, but they are electrically separated by some mediums called dielectric. Dielectric usually consists of mediums like air, ceramics, plastic or some form of a liquid gel as used in electrolytic capacitors.

Due to Dielectric, DC current cannot flow through the capacitor as it blocks it allowing instead a voltage to be present across the plates in the form of an electric charge.

When used in a direct current or DC circuit, a capacitor charges up to its supply voltage but blocks the flow of current through it because the dielectric of a capacitor is non-conductive and basically an insulator. However, when a capacitor is connected to an alternating current or AC circuit, the flow of the current appears to pass straight through the capacitor with little or no resistance.

There are two types of electrical charge, positive charge in the form of Protons and negative charge in the form of Electrons. When a DC voltage is placed across a capacitor, the positive (+ve) charge quickly accumulates on one plate while a corresponding and opposite negative (-ve) charge accumulates on the other plate. For every particle of +ve charge that arrives at one plate a charge of the same sign will depart from the -ve plate.

Then the plates remain charge neutral and a potential difference due to this charge is established between the two plates. Once the capacitor reaches its steady state condition an electrical current is unable to flow through the capacitor itself and around the circuit due to the insulating properties of the dielectric used to separate the plates.

The flow of electrons onto the plates is known as the capacitors Charging Current which continues to flow until the voltage across both plates (and hence the capacitor) is equal to the applied voltage Vc. At this point the capacitor is said to be “fully charged” with electrons.

***EXPLANATION:***

Capacitance is the ability to store electrical energy. Almost all things, including

You, can store some electrical energy and therefore have capacitance. When you

Rub your feet across a carpet, charged particles called electrons can be

Transferred from the carpet to you. When positive and negative charges are

Separated, the stored electrical energy increases. The charges you have picked up

From the carpet give you electrical energy that you store until you touch

Something like a metal doorknob or another person that allows the energy to be

Released. You feel this as a mild shock as the energy leaves your body.

Standard Units of Capacitance

• Microfarad (μF) 1μF = 1/1,000,000 = 0.000001 = 10-6 F

• Nano farad (nF) 1nF = 1/1,000,000,000 = 0.000000001 = 10-9 F

• Pico farad (pF) 1pF = 1/1,000,000,000,000 = 0.000000000001 = 10-12 F

***APPLICATIONS:***

There are quite a few applications of capacitance. Some of which are discussed

Below:

***ENERGY STORAGE:***

A capacitor can store electric energy when it is connected to its charging circuit. And when it is disconnected from its charging circuit, it can dissipate that stored energy, so it can be used like a temporary battery. Capacitors are commonly used in electronic devices to maintain power supply while batteries are being changed. (This prevents loss of information in volatile memory.)

Conventional electrostatic capacitors provide less than 360 joules per kilogram of energy density, while capacitors using developing technology can provide more than 2.52 kilojoules per kilogram.[1]

In car audio systems, large capacitors store energy for the amplifier to use on demand.

***PULSED POWER AND WEAPONS:***

Groups of large, specially constructed, low-inductance high-voltage capacitors (capacitor banks) are used to supply huge pulses of current for many pulsed power applications. These include electromagnetic forming, Marx generators, pulsed lasers (especially TEA lasers), and pulse forming networks, fusion research, and particle accelerators.

Large capacitor banks (reservoirs) are used as energy sources for the exploding-bridge wire detonators or slapper detonators in nuclear weapons and other specialty weapons. Experimental work is under way using banks of capacitors as power sources for electromagnetic armor and electromagnetic railguns or coil guns

***POWER CONDITIONING***

Reservoir capacitors are used in power supplies where they smooth the output of a full or half wave rectifier. They can also be used in charge pump circuits as the energy storage element in the generation of higher voltages than the input voltage.

Capacitors are connected in parallel with the DC power circuits of most electronic devices to smooth current fluctuations for signal or control circuits. Audio equipment, for example, uses several capacitors in this way, to shunt away power line hum before it gets into the signal circuitry. The capacitors act as a local reserve for the DC power source, and bypass AC currents from the power supply. This is used in car audio applications, when a stiffening capacitor compensates for the inductance and resistance of the leads to the lead-acid car battery.

***POWER FACTOR CORRECTION***

In electric power distribution, capacitors are used for power factor correction. Such capacitors often come as three capacitors connected as a three phase load. Usually, the values of these capacitors are given not in farads but rather as a reactive power in volt-amperes reactive (VAr). The purpose is to counteract inductive loading from devices like electric motors and transmission lines to make the load appear to be mostly resistive. Individual motor or lamp loads may have capacitors for power factor correction, or larger sets of capacitors (usually with automatic switching devices) may be installed at a load center within a building or in a large utility substation. In high-voltage direct current transmission systems, power factor correction capacitors may have tuning inductors to suppress harmonic currents that would otherwise be injected into the AC power system.

***SUPPRESSION AND COUPLING***

***SIGNAL COUPLING***

Because capacitors pass AC but block DC signals (when charged up to the applied DC voltage), they are often used to separate the AC and DC components of a signal. This method is known as AC coupling or "capacitive coupling". Here, a large value of capacitance, whose value need not be accurately controlled, but whose reactance is small at the signal frequency, is employed.

***DC BLOCKING CAPACITOR:***

In this application the capacitor blocks the passage of DC current (after

Completely charged) and yet allows the AC to pass at certain portion of a

Circuit.

***CAPACITOR AS A FILTER:***

Capacitors are the main elements of filters. There are several types of filters

That are used in electronic circuits, such as LPF (Low Pass Filter), HPF (high

Pass Filter), BPF (Band Pass Filter), etc.... Since the reactance of the Capac

It or is inversely related to the frequency, therefore it can be used to increase

Or decrease the impedance of the circuit at certain frequencies and therefore does the filtration job.

***CAPACITOR AS A DISCHARGE UNIT:***

Capacitors used as a charging unit and the release of the charge (discharge

Energy) is used for triggering, ignition, and in high scale as a power source.

***PULSED POWER AND WEAPONS:***

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***PARTICLE ACCELERATORS.***

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Bridge wire detonators or slapper detonators in nuclear weapons and other specialty

Weapons. Experimental work is under way using banks of capacitors as power

Sources for electromagnetic armor and electromagnetic railguns or coil guns.

***MOTOR STARTERS:***

In single phase squirrel cage motors, the primary winding within the motor housing

Is not capable of starting a rotational motion on the rotor, but is capable of

Sustaining one. To start the motor, a secondary winding is used in series with a

Non-polarized starting capacitor to introduce a lag in the sinusoidal current

Through the starting winding. When the secondary winding is placed at an angle

With respect to the primary winding, a rotating electric field is created. The force of

The rotational field is not constant, but is sufficient to start the rotor spinning. When

The rotor comes close to operating speed, a centrifugal switch (or current-sensitive

Relay in series with the main winding) disconnects the capacitor.

***NOISE FILTERS AND SNUBBERS***

[](https://en.wikipedia.org/wiki/File:GTO-P1180590b.JPG)

***HEAVY-DUTY SNUBBER CAPACITOR WITH SCREW TERMINALS***

When an inductive circuit is opened, the current through the inductance collapses quickly, creating a large voltage across the open circuit of the switch or relay. If the inductance is large enough, the energy will generate an [electric spark](https://en.wikipedia.org/wiki/Electric_spark), causing the contact points to oxidize, deteriorate, or sometimes weld together, or destroying a solid-state switch. A [snubber](https://en.wikipedia.org/wiki/Snubber) capacitor across the newly opened circuit creates a path for this impulse to bypass the contact points, thereby preserving their life; these were commonly found in [contact breaker](https://en.wikipedia.org/wiki/Contact_breaker) [ignition systems](https://en.wikipedia.org/wiki/Ignition_system), for instance. Similarly, in smaller scale circuits, the spark may not be enough to damage the switch but will still [radiate](https://en.wikipedia.org/wiki/Spark-gap_transmitter) undesirable [radio frequency interference](https://en.wikipedia.org/wiki/Radio_frequency_interference) (RFI), which a **filter** capacitor absorbs. Snubber capacitors are usually employed with a low-value resistor in series, to dissipate energy and minimize RFI. Such resistor-capacitor combinations are available in a single package.

* Capacitors are also used in parallel to interrupt units of a high-voltage [circuit breaker](https://en.wikipedia.org/wiki/Circuit_breaker) in order to equally distribute the voltage between these units. In this case they are called grading capacitors.
* In schematic diagrams, a capacitor used primarily for DC charge storage is often drawn vertically in circuit diagrams with the lower, more negative, plate drawn as an arc. The straight plate indicates the positive terminal of the device, if it is polarized